

## ***Riethia* (Kieffer 1917) (Diptera: Chironomidae) revised for the Austro-Pacific region**

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### **Abstract**

*Riethia* Kieffer, known previously from New Zealand for a species stated to be also in Australia plus several Australian and South American species, is revised for the Austro-Pacific region. The three previously-described Australian species *Riethia stictoptera* Kieffer (the genotype), *Riethia cinctipes* Freeman and *Riethia plumosa* Freeman are distinct and valid, and are redescribed in all stages. In contrast, *Riethia zeylandica* Freeman now is restricted to New Zealand: Australian specimens previously allocated to *R. zeylandica* belong to several new species recognised on morphology of adult male, pupa and larva, with guidance from molecular data. Most belong to a widespread eastern Australian *Riethia azeylelandica* **sp. n.**: others are allocated to *Riethia hamodivisa* **sp. n.**, *Riethia paluma* **sp. n.**, *Riethia phengari* **sp. n.** and *Riethia queenslandensis* **sp. n.**, each with a more restricted range. From Western Australia three species, *Riethia donedwardi* **sp. n.**, *Riethia noongar* **sp. n.** and *Riethia wazeylelandica* **sp. n.**, are described as new from adult male, pupa and larva. *Riethia kakadu* **sp. n.** is described from the monsoonal tropics of Northern Territory from the adult male and tentatively associated pupa. From New Caledonia a reared species is described as *Riethia neocaledonica* **sp. n.**. Illustrated identification keys are provided for the males, pupae and larvae. Unassociated larvae that key to reared described species are excluded from type status, and based on morphology and molecular evidence three unreared larval types, ‘A’, ‘B’ and ‘C’, are also described and keyed. Previously reported molecular vouchers are reviewed, and certain Genbank accessions re-identified. Extensive data shows *Riethia* are distributed almost throughout Australia from standing and flowing waters, from tropics and subtropics to cool temperate Tasmania, but probably only in permanent and standing waters. The immature stages of several taxa can co-occur: as many as four can be found simultaneously in one site. Terminology of the volsellae of the male genitalia and the dorsal head and maxilla of the larva is reviewed.

**Key words:** Australia, New Zealand, New Caledonia, new species, life stages, volsella, clypeus

### **Introduction**

*Riethia* (Chironomidae, subfamily Chironominae) was erected by Kieffer (1917) based on Australian specimens. Although the genotype *Riethia stictoptera* Kieffer 1917 lacks extant types, its identity and thus the validity of the genus is certain. Species diversity is highest in Australia (Freeman 1961; Cranston 1996, 2000) and from South America, Edwards (1931) recognised two species, now recognised as synonymous (Trivinho-Strixino *et al.* 2009). Freeman (1959) reported *Riethia* from New Zealand with the included species *Riethia zeylandica* Freeman with a subsequent report from Australia (Freeman 1961). In this work Freeman described *Riethia plumosa* Freeman and *Riethia cinctipes* Freeman as new, adding them to the genotype *R. stictoptera* Kieffer. In surveys of the Australian Chironomidae, Cranston (1996; 2000) provided keys and illustrations for the first time to larvae and pupae of the described Australian *Riethia*, to which were added 4 larval and 5 pupal taxa under informal codes. Although adults were not included and distributional data were minimal, all were incorporated in Trivinho-Strixino *et al.* (2009) in providing generic diagnoses for each life stage with data derived from an unpublished study of adult males. Despite these studies, Neuburn *et al.* (2011: 595) state correctly that ‘a comprehensive revision of the genus remains unavailable’. A hiatus in formal descriptive studies of Austro-Pacific *Riethia* was due to an anticipation that molecular data would assist in species discrimination and in elucidating relationships. Now with some genetic data available (Nick Herald, Davis, California, *pers. comm.*), it is timely to provide morphological descriptions of the Australian, New Zealand and New Caledonian species, to allow inclusion of well-delimited and formally named taxa into Australian biomonitoring and biodiversity studies.

## Methods and materials

Pupae, their exuviae and drowned pharate adults were sought by exposing drift nets with a 300 µm mesh for up to 24 h. to intersect flowing water. Larvae were collected into kick nets by disturbing lotic and lentic substrate and marginal habitats. Adult midges were sought by sweeping marginal vegetation beside known natal sites, and malaise and light traps were used sporadically. By preference and when suitable, aquatic samples were field-sorted with a dissector microscope especially to seek live larvae for individual rearing and to allow return of live by-catch. Life history associations necessary for full taxonomic descriptions were sought by placing individual live larvae in a few ml of native water in 10 x 50 mm vials stoppered with cotton wool, and maintained at cooler than ambient temperature, without aeration. Any emerged or teneral adult and associated immature stage exuviae were preserved by addition of 70–90% isopropanol (propan-2-ol) to the natal vial to maintain associated parts during any transfer. Material for molecular study, predominantly of larvae, was vouchered by slide mounting head capsule and posterior larval segment, allowing destructive extractions from the mid-section of the larval body (Krosch & Cranston 2012).

Emphasis on the immature stages but poor rearing success led to infrequent adults often in sub-optimal condition for descriptive taxonomy. For this reason some rarer species are known only as pharate (incompletely developed, with a teneral adult retained within its pupa) specimens. Diagnostic features from these include at least the genitalia, but lack mature pigmentation including for wings and legs, and the lengths of leg and antennal segments and ratios derived therefrom are necessarily inexact. Mensural features are impacted also by the high size variation (allometry) across widely distributed species (McKie & Cranston 2005). Most female adults identifiable from rearings are pharate and unsuited for extended descriptive and diagnostic taxonomy and the homogeneity of females prevents keying beyond recognising that the pigmentation of conspecific males applies to the female. Measurement of hyaline body structures of larval exuviae causes problems as does uncertainty of identity of un-reared larvae in which structures such as anal tubules and procercus are more visible. Although permanent slide mounts are preferred (see Cranston 2013) many un-reared larvae were mounted in Hoyer's solution, a potentially impermanent medium but with excellent optical properties and rapid clearing that allows rapid identification for onward molecular processing. Minimally the genitalia of pharate adults have been dissected from within exuviae. Pupal exuviae were displayed by dissecting the cephalothorax from the abdomen.

Phase contrast and Nomarski optics are needed to understand hyaline structures in all stages. Photography can illustrate many taxonomic features, my preference increasingly is to return to ink, using a tube and tracing film to produce 'synthetic' line art to illustrate, for example, complete pupal abdomens, and fine details of larval head and male genitalia. Illustrations of male genitalia emphasise volsellae, which are drawn for all species (Fig. 2) but the full hypopygia shown only for a representative subset (Fig. 1) because species in the 'zeylandica group' show similar anal tergite, gonocoxite and gonostylus. Poor differentiation of the gonostylus from the gonocoxite means that these lengths and derived ratios are not tabulated (Table 1).

Morphological terminology follows Sæther (1980), Cranston (1994, 2013) and Cranston *et al.* (1989). Measurements of most larvae and pupae are taken predominantly from exuviae. Head capsule details are provided from only fourth-instar larvae. Larval antennal measures are based on the individual sclerotised length, however the calculated antennal ratio is based on the linear total length of post-basal segments (i.e. including variably distended membranous intersegmental regions). Larval head capsule size (H.L.) is the length from most anterior labrum to the dorsal posterior head; postmentum length (pm.l.) is measured from the tip of the median mental tooth to the ventral postoccipital margin, which is less susceptible to deformation than the 'total' head length. Cuticular structures located on a pupal conjunctive are treated as if belonging to the tergite immediately anterior. A pupal feature little mentioned previously, the longitudinal 'creasing' anterior and lateral to spinules on the anterior of tergites visible best in exuviae, may be diagnostic for *Riethia*. In some examples, each crease clearly terminates posteriorly in a spinule. Creasing varies between species and may be weakly expressed. In general 'creasing' is strongest on the anterior of tergites III and IV and in descriptions creasing referred to (and illustrated) as 'weak' or 'strong' refers to the relative strength on these segments.

The hypopygial volsellae need review. Pinho *et al.* (2013) defined the median volsella as originating ventral to the superior volsella in an intermediate level between superior and inferior volsellae. For any other projection at a different level they introduced the term 'microtrichiose' projection with evidence from *Beardius* Reiss & Sublette in which a few species have a 'typical' median volsella by location and morphology plus an additional setose tubercle (Pinho *et al.* 2013). Past treatment of both structures as 'median volsellae' is confusing. What has been

termed a median volsella in *Riethia* cannot by location and structure be homologous with the ‘true’ median volsella of Pinho *et al.* (2013) that is exemplified, for example, in members of the tribe Tanytarsini and *Paratendipes* Kieffer, *Kribiodorum* Kieffer (Cranston 2018a), *Paraskusella* Cranston 2018b, etc, in that the structure lacks a stem, has only few simple setae and arises from the inner gonocoxite. This truly represents a cluster of some anterior to distal strong setae that are linearly-aligned along the medio-dorsal contour of the gonocoxite, starting near the fusion of the gonocoxites and terminating dorsal of, and anterior to, the superior volsella. Illustrations by ZSM artists in Cranston *et al.* (1989) show usually 4–5 of these setae, less often 6 or rarely more in some larger adults of the Chironomini. This arrangement is consistent in taxa possessing a ‘typical’ median volsella such as *Beardius* (Pinho *et al.* 2013). In *Riethia* in some species of which a tubercle-like ‘median volsella’ has been postulated, 2–3 distal inner gonocoxite setae are aggregated with their setigers (bases) incorporated into a weakly developed tuberculose bulge, or are placed on an angle of the inner gonocoxite: both aggregations are more ventral than the origin of the superior volsella. In recognition of its resemblance to a very reduced volsella, when enlarged setigers are aggregated, here I term this a (gonocoxal) pseudovolsella. In species of *Riethia* with such an aggregate, the consistent gonocoxal setal count (4–) 6 indicate their homology. In other species of *Riethia* this pseudovolsella is not indicated—the gonocoxal setae are aligned evenly, unclustered and with conventionally small setigers. Clearly a ‘true’ median volsella is absent in *Riethia* and thus the term ‘pseudovolsella’ is used throughout.

A second issue concerns the superior volsella, which is visibly bipartite in most species. The prominent feature is an apically bare (non-microtrichiose) finger-like appendage, here termed the digitus of the superior volsella. It bears some simple setae and in some species also ‘moth-like’ scale setae, located both apically and subapically and in one species, near the base. This digitus arises from a microtrichiose lobe of variable size that is either separated from the inferior volsella or showing a mid to apical fusion. An isolated separate lobe is most evident in *R. plumosa* (Fig. 2I) and *R. wazeylandica* (Fig. 2L). These species differ in development of scale setae, especially dorsally around the apex of the distal lobe of the superior volsella (Fig. 2M) in *R. zeylandica* or their absence (Fig. 2I) in *R. plumosa*.

*Maxilla.* Structures associated with the maxillary lacinia, the ventromesal lobe bearing several projections termed ‘chaetae’ and ‘setae’, vary in ‘tribe’ Pseudochironomini. In several genera allocated to this ill-defined likely grade, there are one to three transverse medially-directed projections of the lacinia located at the level of, and orientated dorsal to the mental teeth. In other taxa projections are shorter and orientated more anteriorly from the lacinia. In his glossary of chironomid terminology Saether (1980) refers to some of these as lacinial chaetae, and figures a dorsal view of the structures (labelled ‘La’, ‘LCh’) in *Chironomus anthracinus* (Saether 1980: Fig. 75). Examination of these structures under maximum magnification reveals no socket or other evidence that these are chaetae (or setae or sensillae): their cuticle is continuous with lacinia without any evident baseline. They are simply projections of the corpus of the lacinia, as distinct from other nearby structures with a base (aforementioned chaetae, setae, sensillae). These lacinial projections have significance in *Riethia* and related genera. In *Riethia* (Fig. 5J) there are 3 projections, 2 of which are elongate in comparison to the 3<sup>rd</sup>, which is located at their bases. These dual projections are blade-like, unequal in length and width, with the longest extending to meet the projection from the lacinia of the opposite palp, dorsal to the midtooth of the mentum. All larval *Pseudochironomus* Malloch examined from the northern Hemisphere and south America are quite similar (Fig. 5K), but the long bifid projections are subequal in length and width, taper gradually and may curve apically (as in Saether 1977: fig. 26F) and extend beyond the mid-mentum to overlap with the opposite structure.

In the larvae of *Manoa*, two patterns can be seen. In *M. pahayokeensis* a solitary medially-directed triangular projection dominates, with all other parts short and difficult to differentiate (Fig. 5M, after Jacobsen & Perry 2002). In *Manoa obscura* 3 putative lacinial projections are directed antero-medially (Fig. 5O, drawn M. Spies *pers. comm.*). A potential larva of *Megacentron* Freeman from Australia has three modest-lengthed and somewhat anteriorly-directed projections (Fig. 5N). In *Aedokritus coffeatus* Trivinho-Strixino a cluster on the lacinial apex may be interpreted as 3 short projections plus at least 2 sensillae, all directed anteriorly (Fig. 5L). An anomalous taxon with regard to these features is a larva identified as *Riethia truncatocaudata* Edwards from Brazil that has the elongate and tapering lacinial projections characteristic of *Pseudochironomus*. The significance is unclear.

*Clypeus of Riethia (and other ‘Pseudochironomini’).* In all species of *Riethia*, the clypeal sclerite is separated from the frons (posteriorly) and labral sclerite (anteriorly). It bears within its sclerotised structure the clypeal setae (S3) (terminology follows Cranston 2012). The location of these setae on a separate clypeal sclerite in *Riethia* is quite unusual, otherwise found only in larvae of other taxa in the putative tribe Pseudochironomini (*Aedokritus*

Roback, *Manoa* Fittkau and *Pseudochironomus*) plus *Lauterborniella* Thienemann & Bause and *Glyptotendipes* (*Heynotendipes*) Kieffer. In *Microtendipes* Kieffer and *Endochironomus* Kieffer the clypeal setae originate near the clypeal margin rather than within the lesser sclerotised area. Details of the dimensions and shape of the clypeus and location of the clypeal setae show species-informative variation in well-studied genera of Chironomini, namely *Goeldichironomus* Fittkau (Reiss 1974), the *Endochironomus* group (Grodhaus 1987) and *Kiefferulus* Goetghebuer (Cranston 2007). Dorsal head morphology often supports species distinction congruent with delimitation based on other life stages and molecular data. Clypeal features have proved valuable in discriminating larvae of what previously was considered the widespread *Riethia zeylandica* (Fig. 6), confirming that subtle features of pupae and adult males and unpublished data from DNA confirm a suite of valid, often allopatric, so-called ‘cryptic’, species.

Unless indicated otherwise (mm), measurements are in microns ( $\mu\text{m}$ ) rounded appropriately for the magnification used: only measurement at maximum magnification ( $\times 1000$ ) provides ‘accuracy’ to 1  $\mu\text{m}$ . Larger numbers of specimens may have been examined than the ‘ $n=x$ ’ implies, seeking outlying values. Distributional information for material examined is based on slide-mounted specimens. Larval identifications were validated where possible against molecular evidence for species taxonomy. Unreared larvae are excluded from type series for new taxa. Most of these were collected for molecular study and are listed separately, identified by ‘MV’ and individual taxon codes. For successful extractions and inclusion in multigene analyses, codes are highlighted in **bold** to distinguish from barcode sequences only (*italics*) and ‘failures’, in regular font. Data are organised from clockwise, in eastern Australia (Queensland, New South Wales, Australian Capital Territory, Victoria, Tasmania) from north to south, followed by South Australia, and Western Australia and Northern Territory from south to north. For multiple specimens from a sole location, if  $n=1$  the ‘1’ is omitted (hence ♂ for one male, 2P♂ for two male pupae, etc). Geographic co-ordinates were derived from topographic maps, GPS-derived, and occasionally from Google Earth™. Elevational data is cited only if present on original label data, cited as m a.s.l. (metres above sea level), however calculated. Collections prior to 2000 were databased by ANIC and are cited here as #xxxx (omitted is the invariate prefix 29.00).

#### Abbreviations

*Morphology.* *Ac*, acrostical setae (count); *Ant* (1–5), antennal segment lengths (larva); *AR*, Antennal Ratio = (adults): length of terminal flagellomere divided by combined length of preceding flagellomeres, (larva): length of basal segment divided by combined lengths of segments 2–6; *As.l.* anal setae length; *As.n.* anal setae (count); *B.l.*, Body length (an approximation) in m.m.; *BV<sub>n</sub>*, “Beinverhältnis”: length of femur, tibia plus first tarsomere / combined length of tarsomeres 2–5; *c.*, circa (about); *clyp*, clypeus setae (count); *Dc*, dorsocentral setae (count); *Fe*, Femur length; *Fl*, antennal flagellomere, thus *Fl<sub>1–12</sub>* = lengths of 1–12 combined (adult male); *H.l.*, head capsule length (larva); *L*, larva; *L.aps*, lateral antepronotals; *Le*, larval exuviae; *Le/Pe/♂(♀)*, reared adult male (female) with associated larval skin, pupal exuviae; *LR<sub>n</sub>*, Leg Ratio = tarsomere 1 length / tibia length; *Md*—mandible length; *MV*, molecular voucher; *M.w.* mentum width (Fig. 5B); *n*, number of specimens measured; *P<sub>1–3</sub>*, Leg(s) (1 = fore, 2 = mid, 3 = hind leg); *Pa*, prealar setae (count); *Palp<sub>2–5</sub>*, palpomere length; *Pc.h.* height of procerus; *Pc.w.* width of procerus; *P(e)*, Pupa (exuviae); *Pm.l.*, postmentum length; *Pmd*, premandibular teeth (count); *R*, *R<sub>1</sub>*, *R<sub>4+5</sub>*, respective setae (count) on wing veins R, *R<sub>1</sub>*, *R<sub>4+5</sub>*; *Scts*, scutellar setae (count); *SV<sub>n</sub>*, “Schenkel-Schiene-Verhältnis” = combined length of femur and tibia / length of first tarsal segment; *Sq*, squamal setae (count); *Svo*, superior volsella; *temp*, temporal setae (count); *TLX*, male tergite IX; *Ta<sub>1–5</sub>*, Tarsomere lengths; *Ti*, Tibia length; *Vm.w.* Ventromental plate width; *Vm-mR*, ratio of ventromental plate width to mentum width (Fig. 5B); *VR*, vein ratio = length of Cu / length of M; *W.l.*, Wing length (arculus to apex) in mm.

*Geography.* *ACT*, Australian Capital Territory (Australia); *Ck*, Creek; *E*, East; *L.* Lake; *N*, North; *N.P.*, National Park; *NSW*, New South Wales (Australia); *NT*, Northern Territory (Australia); *Qld*, Queensland (Australia); *R.*, River; *S*, South; *SA*, South Australia; *Vic*, Victoria (Australia); *W*, West; *WA*, Western Australia.

*Institutions.* ANIC, Australian National Insect Collection, Canberra, Australia; BMNH, The Natural History Museum, London, UK; MNHM, Muséum national d’Histoire Naturelle, Paris, France; WAM, Western Australian Museum, Perth, Australia; ZSM, Zoologische Staatssammlung München, Munich, Germany.

## Taxonomic results

*Riethia* Kieffer 1917: 203.

*Riethia stictoptera* Kieffer 1917, genotype (as gen.n., sp.n.)



**Generic diagnosis.** Generic diagnoses for *Riethia* follow Trivinho-Strixino *et al.* (2009). These diagnoses were based on all formally and informally described species at that time, including all stages of species from South America plus those at that time recognised from Australia, New Zealand and New Caledonia. Subsequently Neubern *et al.* (2011) in describing a new species *Riethia manauara* Neubern, Trivinho-Strixino & Silva from Amazonian Brazil noted several exceptional character states that extend diagnoses. These were the inferior volsella of the male genitalia can bear flattened scales (as well as the frequent pectinate ('moth scale') setae), the pupa may lack transverse spinule bands on any conjunctive and lack pedes spurii A (vortex), and in the larva the antenna can be six-segmented with Lauterborn organs alternate on apices of 2<sup>nd</sup> and 3<sup>rd</sup> segments. The vortex may be absent or weakly indicated, when present it is only on SIV. Most interesting are the flattened 'moth' scales on the apices also of the inferior volsella in *Riethia neocaledonica*. No Austro-Pacific species show the larval antennal features of *R. manauara*. The only deviant character state found in the Austro-Pacific region is the simple (non-taeniate) lateral setae (LS) on segment V in *R. zeylandica*. Otherwise, the diagnosis of Trivinho-Strixino *et al.* (2009) applies to all taxa considered here.

## Descriptive taxonomy

### *Riethia azeylelandica* Cranston sp. n.

(Figs. 2A, 3A, 3D, 3I, 5D, 6D)

urn:lsid:zoobank.org:act:611E950D-9560-4B46-B6F1-7E2156551D3E

*Riethia zeylandica* (pro parte): Cranston 1996; 2000.

**Type material. Holotype** Le/Pe/♂, AUSTRALIA, Australian Capital Territory, Namadgi N.P., Brindabellas, Lees Ck., 35°22'S 148°50'E, 12–13.i.1998 (Cranston) (ANIC). Paratypes (collected Cranston, deposited ANIC, unless otherwise stated): Queensland: 3Pe [1 on same slide as paratype of *R. queenslandensis*], Mt. Haig, Emerald Ck., 17°06'24"S 145°36'52"E, 17–18.xii.1997, #2219; Pe, Palmerston N.P., Learmouth Ck., 650 m.a.s.l, 17°35'S 145°42'E, 8–9.iv.1997, #2220; 1♂, Cardwell, 5-mile Ck., 18°20'S 146°03'E, 1–4.iv.1997; 2Pe, N.W. Brisbane, Bundaroo Ck., 26°42'S 152°34'E, 27.ix.1989, #2218.

New South Wales, 2Pe, Chaelundi S.F., Chandlers Ck., 30°02.22'S 152°29.26'E, 11.iv.1996, #2221; Pe, nr Dorrigo, Eve Ck., 30°16'S 152°50'E, 9.x.1996, #2222; Pe, Warrumbungles, Timor Rock. Shawn's Ck., 31°16'S 149°09'E, 15.ix.1989, #2223; ♂ pinned, abdomen on celluloid mount, 'Hornsby', 2/12/1958 (*D.J. Lee*) det. Freeman; 6L, 2Pe, 34°24'S 149°09'E, Macquarie Pass, Macquarie Rivulet, 12.iii.1994, #2224; Pe, Endrick R., 6 km e. Nerriga, 35°05'S 150°08'E, 1.ix.1988, #2227; Le/Pe/♂, Kangaroo Valley, Bugong Rd., 12.xi.1990 (*Edward*), #2226; Pe, Micalong Ck., 35°17'S 148°31'E, 14.i.1992, #2228; Pe, Budawangs, Yadboro R., 28–29.xii.1993 #2229; Le/P♀, Bimberamala Ck., 28.ix.1996 (Cranston & Gullan), #2230; 2Le/Pe/♂, 4Pe, Currowan S.F., Cabbage Tree Ck., 35°34'S 150°02'E, 30.iii.1994, #2229; L, Pe, Monga, Mongarlowe R., 35°23'S 149°55'E, 2.ii.1991, #2234; 2Pe, Brindabella, Goodradigbee R., 35°23'54"S 148°44'51"E, 4.i.2001; 6Pe, Kosciuszko N.P., Murrumbidgee R., 35°38'S 148°34'E, 13–14.xi.1993, #2232; 3Pe, Yarrangobilly R., 14–15.i.1991, #2233; 2Pe, above Captains Flat, Molonglo R., 35°35'S 149°28'E, 6.iii.1993, #2235; 8L, -.v.1988 (*Atkins*); 2Pe, Brown Mountain, Rutherford Ck., 36°36'S 149°47'E, 16.x.1990 (Cranston & Edward), #2239; Pe/♂, 3Pe, same except 4.iii.2009 (MV NSWRCR1); 2Pe, Mt Imlay, Wallagaraugh R., 37°15'S 149°41'E, 13.i.1994, #2240; 3Pe, Imlay Ck., 13.i.1994; 37°16'S 149°40'E.

Australian Capital Territory, Brindabellas, Bramina Ck., 35°16'S 148°45'E, 29.viii.1988, #2242; ♂, Black Mt, malaise trap, 35°16'S 149°06'E, -.i.1988 (*Irwin*) #2251; ♂, L. Burley Griffin, 35°18'S 149°07'E, 18.x.1988, #2243; ♂, Cotter, Paddys R. 15.ix.1988; 35°18'S 149°07'E, 15.ix.1988; #2244; Pe, Pierces Ck., 35°20'S 148°56'E, 24.x.1991 (*Drayson*) #2252; 2Pe, Vanity Crossing, Cotter R., 16.x.1991, 35°21'S 148°53'E, 16.x.1991 (*Drayson*) #2252; L, Warks Ck., 35°21'S 148°52'E, 26.iv.1988 (*Calder*) #2244; 3Pe, Brindabellas, Lees Ck., 35°22'S 148°50'E, 12–13.i.1998; 3L, Le/P♂, Le, Pe/♀, Condor Ck., 35°22'S 148°51'E, 6.iii.1988, #2246-8, 2Pe, 24.iii.1991, #2249; ♂, 7–13.iii.1998, #2254; Le/Pe/♀, Blundells Ck., 35°22'S 148°50'E, .ix.1999; L, Namadgi N.P., Orroral R., 35°39'S 148°59'E, 21.ii.1988, #2250; Pe, Namadgi N.P., Gudgenby R., 35°41'S 149°00'E, 14.ii.1988; ♂, Brindabellas, Bushranger Ck., ex-wood, 35°25'S 148°50'E, 23.i.1996 (*McKie*) #2255. ♂ (slide from pinned, by Cranston), 'Lee Spring', 13.xi.1938 (*A.L. Tonnoir*), det. Freeman.

Victoria, 2Le/Pe/♂, Le/Pe, 2Pe, 2♂, Buckland R., 36°48'S 146°51'E, 4.vii.1991 (Cook) #2261-3; Le/Pe/♂, Le/Pe, 6.xi.1990 (Cook) #2256-7; Le/Pe/♂, 3Pe, 1♂, 6.v.1991 (Cook, Cranston, Nielsen) #2260; Pe, 2P♂, P♀, Tambo R., 'TPC', 36°57'S 147°56'E, 27.iii.1991 (Hortle) #2276; 2Pe, P♂, 'CC10', 23.iii.1990 (Hortle) #2264; P♂, 'TBTS' 36°59'S 147°51'E, 28.iii.1991 (Hortle) #2267; P♂, d/s S. branch, 37°01'S 147°53'E, 8.iii.1990 (Hortle) #2265; 22.iii.1990; P♀, 'up Wilga Weir', 37°00'S 147°52'E, 30.iii.1993 (Hortle) #2275; 15L, 2L/P, 3Pe, P♀, 2P♂, Bindi, 37°08'S 147°49'E, 23.iii.1991 (Hortle) #2269-74; L, 1♂, Cumberland Falls, 38°34'S 143°56'E, .xii.1971 (Fuehrer).

Tasmania: 1♂, L. Price, 41°50'S 146°08'E, 24.i.1990, #2279.

**Other material.** Queensland, 2L, Lamington N.P., Coomera R., 26°11'S 153°10'E, 25.viii.2007 (Krosch) (MV SEQ15, 23). New South Wales: 3L (on 1 slide) Currowan S.F., Cabbage Tree Ck., 35°34'S 150°02'E, 2.i.2009 (MV AU09CTCR11-13); 12L, Glenbog SF., Brown Mt, Fastigata Rd, Rutherford Ck., 36°36'S 149°47'E, 909 m a.s.l., 4.ii.2009 (MV NSWGCR2-7, 10-15), 2L same except 27.xi.2010 (MV NSWBMR3, 4); ACT: L, Blundell's Ck., .2010 (Krosch) (MV BLCR2). Victoria, L, 8 km s Mitta Mitta, Snowy Ck., 36°34'13"S 147°24'58"E, 19.ii.2005 (MV V903) (misidentified previously as *R. stictoptera* (in Cranston *et al.* 2012); L, Buckland R., 36°47'46"S 146°50.57"E, 18.ii.2005 (MV V507); L, Fyans Ck., Grampians Bridge Rd, 37°15'S 142°32'E, 11.xi.2009 (Brooks) (MV AU09RCR1); 4L, Grampians N.P., Zumsteins, Mackenzie R., 37°05'S 142°51'E, 7-8.i.2001 (MV VIC-11GZR4, 1, 2, 3), 3L, downstream Zumsteins, 37°05'34"S 142°20'29"E, 11.xi.2009 (Brooks) (MV AU09MKRR2, 1,3).

**Description. Male.** Thorax brown, with darker vittae; legs brown, without banding. Wing membrane clouded around veins and in anal area; veins yellow-brown. Setae of TIX fine, evenly distributed. Gonostylus merged with gonocoxite, which bears only simple setae. Superior volsella (Fig. 2A) predominantly bare, excepting 4–5 long setae disto-laterally, posterior setose projection weak and contiguous with inferior volsella, medially-directed apically rounded digitus devoid of microtrichia, with 7–9 simple setae; inferior volsella well developed, basally appressed to inner contour of gonocoxite and linked to superior volsella, with 6–7 pectinate scales and many long simple setae. Pseudovolsella 3 weakly clustered long setae without tubercle development (Fig. 2A). Mensural features as in Table 1.

**Female.** Pigmentation as in male, AR 0.4. LR not measurable.

**Pupa.** Pale yellow with darker yellow dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb yellow-brown. Frons with very weak warts (Fig. 3A), cephalothorax rugulose with several rows of dorsal tubercles. Abdomen (Fig. 3D) with continuous hook row on II occupying c 50% of tergite width, and complete conjunctival spinule band on III and IV. Pedes spurii B very weak to absent; vortex strong. Tergite II with quite dense armament in hour-glass shape, with anterior transverse band distinctive but not as broad as posterior armament, TIII–V rather similar to TII, perhaps denser, TVI with oval anteromedian patch separated from well-developed posterior band; TVII and VIII almost bare. Taeniate setae V–VIII 3, 4, 4, 5; on VIII evenly distributed along segment. Sternites bare. Comb (Fig. 3I) with 1 stronger posteriorly-directed outer spine and 2–3 weaker subsidiary spines, also directed posteriorly. Anal lobe with 60–65 biserial taeniae.

**Larva.** Head capsule yellow with posterior half of head variably darkened, sometimes equally darkened as brown occipital margin, mandible golden yellow, mentum and inner 4 mandibular teeth brown (innermost 4<sup>th</sup> completely separated from mola). Clypeus (Fig. 6D) trapezoid, with clypeal setae close together, in anterior 1/3 of sclerite. Inner margin of mandible with broad spine beside insertion of seta subdentalis and 3 serrations further towards base of mola. Antenna (Fig. 5D) with AR 1.9–2.1, arising from distinct pedestal, each segment shorter than that preceding (thus 3<sup>rd</sup> shorter than 2<sup>nd</sup>), and 4<sup>th</sup> distinctly shorter than 3<sup>rd</sup>. Mentum and ventromental plate subequal in width. Mensural features as in Table 2.

**Diagnosis.** The adult male of *R. azeyleandica* is distinguished from *R. queenslandensis* (q.v.) only with difficulty, with differences of uncertain significance in shape and setation of the digitus of the superior volsella, notably the presence and number of pectinate setae on the volsellae and a weaker pseudovolsella. Distinction is clearer on the immature stages.

Pupal exuviae of *R. azeyleandica* lack cephalic warts (present in *R. queenslandensis*) and the hook row on II is complete as are the conjunctival bands, which are restricted to III and IV. Differentiation from *R. queenslandensis* relies not solely on the cephalic warts, but notably differing also in the density of spinulation on the posterior tergites (Fig. 4M) and in the spinulose posterior sternites (Fig. 4N). The western Australian *R. noongar* differs in the cephalic warts being separated at their bases, the bare sternites (and TVIII) and perhaps in the clustering of the lateral taeniate seta of segment VIII. In *R. azeyleandica* these setae are more evenly spaced, unlike the clustered L<sub>3-5</sub> in *R.*

*noongar*. Separation from the pupa from *R. phengari* is based on the lack of cephalic warts, the very pale exuviae with faint apophyses, and the number of teeth in the comb (Fig. 4J).

Larvae of *R. azeylelandica* and *R. queenslandensis* have a distinctively darkened posterior head, and resemble one other also in having a well-developed antennal pedestal and high antennal ratio (close to 2) deriving principally from short 3<sup>rd</sup> and 4<sup>th</sup> segments. Seemingly the relative lengths of antennal segments 3 and 4 distinguish—in *R. queenslandensis* these segments are subequal in length, in *R. azeylelandica*, the 3<sup>rd</sup> is clearly longer than 4<sup>th</sup>. The shape of the clypeus (Fig. 6D v. 6M) may distinguish although the amount of variation is larger than illustrated.

**Etymology.** The species epithet is derived by adding the prefix—“a” indicating it not the same species as *R. zeylandica* with which it was confused but which is restricted now to New Zealand.

**Remarks.** This species conforms to the concept of *R. zeylandica* in Australia when Freeman (1961) treated it as conspecific with the New Zealand species (Freeman 1959). Morphology plus unpublished molecular data shows distinction of all Australian species from the New Zealand species. Molecular evidence for some internal structuring cannot be substantiated from morphology due to inability to separate this from the extensive geographic range of molecular samples—from 26°S to 37°S.

Re-examination of the morphology of larva voucher MV903 in Cranston *et al.* (2010) allows re-identification as the new species *R. azeylelandica* and not *R. stictoptera* as stated. This is supported by DNA data.

**Distribution and ecology.** *R. azeylelandica* is sympatric with *R. queenslandensis* in Upper Emerald Creek on Mt. Haig on eastern (coastal) edge of the Atherton Tableland in tropical far North Queensland. This is the most northerly location for *R. azeylelandica*, albeit at over 1000 m. elevation. Otherwise *R. azeylelandica* is a more southern (temperate) species, with *R. queenslandensis* a species more typical of the tropical north. *Riethia azeylelandica* is found in running waters from pristine to heavily polluted (e.g. Molonglo River, Captains Flat, NSW, see Cranston 2017). The only record from Tasmania is an adult male from Lake Price, at an elevation of about 1500 m a.s.l.

### ***Riethia cinctipes* Freeman**

(Figs. 2B, 3E, 3J, 4I, 5A, E, 6E)

*Riethia cinctipes* Freeman 1961; Cranston 1966, 2000.

*Riethia* Pe ‘Brisbane’ Cranston 1966, 2000

**Type material.** Paratypes, ♂, pinned, separate hypopygium on celluloid mount, ‘F.C.T. Blundells’ [AUSTRALIA, Australian Capital Territory, Blundell’s Farm] 18.2.1931, A.L. Tonnoir [ANIC]. *Riethia cinctipes* Freeman det. Freeman 1960 (2 labels); ♀, pinned, ‘Stanwell Pk’ [New South Wales], 2 Mar 23 [1923]; second label as ♂ above.

**Other material** (collected Cranston, deposited ANIC, unless otherwise stated): Queensland, 2♂♂, 1♀, McIlwraith Range, 15 km WNW Bald Hill, 13°43’S 143°19’E, 27.vi.–12.vii.1989 (*Naumann*, ANIC expedition); 1♂, 7 miles N. Hope Vale Mission, 4.x.1980 (at light) (*Colless*) #2542; 5Pe, Emmagen Ck., 16°02.7”S 145°27.0”E, 9/10.ix.1997 (*McKie*) #2068; 2Pe, Mason Ck., 16°05.08”S 145°27.36”E, 23.iv.1999; 3Pe, Oliver Ck., 16°08.3”S 145°26.7”E, 9/10.ix.1997 (*McKie*) #2073, 4, 7Pe, 23.–23.iv.1999; L, 6Pe, Mossman, Rex Ck., 16°28’S 145°19’E, 5–6.iv.1997, #2543, 5; 6Pe, same except 27–28.viii.1997, #2546; 6Pe, same except 17–18.xii.1997, #2544; 2L, Le/P♂, Pe, 19–20.x.1998 (*Cranston & Dimitriadis*) #2076–8; 10Pe, Mt. Lewis, trib. Churchill Ck., 16°34’S 145°20’E, 6–7.iv.1997, #2547–8; 3Pe, Clohesy R., 7–8.ix.1997 (*McKie*) #2067; 5Pe, Mareeba, Davies Ck., above falls, 17°01’S 145°35’E, 11–12.iv.1997 #2549; 2Pe, same except 19–20.vi.1997; Pe, same except 27–28.viii.1997, #2065–66; 2Pe same except 17–18.xii.1997, #2066; 2Pe, Kauri Ck., 11.vi.1997 (*McKie*) #2069; 2Pe, Mt. Haig, ?U. Emerald Ck., 17°06’24”S 145°36’52”E, 17–18.xii.1997, #2550; Pe, Tinaroo, unnamed Ck., 17°09’S 145°37’E, 11–12.vi.1997 (*McKie*) #2075; 4Pe, Bartle Frere, Junction Ck., 17°16’S 145°55’E, 1–4.iv.1997, #2553; Pe, same except 27–28.viii.1997, #2551; 5Pe, same except 17–18.xii.1997, , #2552; 2Pe, Herberton, Carrington Falls Ck., 17°20’S 145°27’E, 9–10.iv.1997, #2554; Pe, Nigger Ck., 17°27’S 145°29’E, #2555; P♂, 8Pe, Palmerston N.P., Learmouth Ck., 17°35’S 145°42’E, #2062, -2556; Tchooratippa Ck., 17°37’S 145°45’E, 8–9.iv.1997, #2557; 2Pe, Python Ck., 17°46.2’S 145°35.4’E, 2–3.xi.1997 (*McKie*) #2072; Pixies Ck., 2–3.ix.1997, 17°47’S 145°41’E (*McKie*), #2070–1; Le/Pe/♂, 2Le/Pe/♀, nr Cardwell, 5-mile Ck., 17.xii.1997, 18°19’S 146°02.55’E, #2064; L, same except 17.xiii.1997; Le/Pe/♀, Paluma, Birthday Ck., 18°58’S 146°09’E, 24.x.1998 (*McKie*); 3Pe, Paluma, unnamed Ck. S. Paluma, 25–26.iii.1998, #2558; Le/Pe/♀, Paluma, Camp Ck., 18°68’S 146°09’E, 5.v.1999 (*Dimitriadis*); Le/P♂, Yacobine Ck., 17.v.1988 (*Edward*), #2061; 2Pe, N.W. Brisbane, Bundaroo Ck., 26°42’S 152°34’E, 27.ix.1989, #2559.

New South Wales: 5Pe, Chaelundi N.P., Chandlers Ck., 30°02.22’S 152°29.26’E, 11.iv.1996, #2560; 9Pe,



nr Dorriggo, Eve Ck., 30°16'S 152°50'E, 9.x.1996, #2056; 2Pe, Barren Ground N.P., Redback Stream, 34°40'S 150°44'E, 9.iv.1994, #2055; Pe, Endrick R., 6 km NE Nerriga, 35°05'S 150°08'E, 1.ix.1988, #2053; Pe/♂, Rutherford Ck., 11.xi.1961 (*Brundin*) (ZSM).

Australian Capital Territory (ACT): Pe, Brindabellas, Lees Ck., 35°22'S 148°50'E, 12–13.i.1998 (*Willis & Cranston*) #2058; same except 24.i.1998 (*Willis*) #2057.

Northern Territory: 4♂, Pe, Kakadu N.P., Radon Spring, 12°45'S 132°55'E, 13–14.iv.1989, #2051; 2Pe, Litchfield N.P., Wongi Falls, 13°10'S 130°41'E, 6.viii.1990, #2054.

Victoria: L., nr Anglesea, Angahook Forest, AV#82.1, 19.iii.1972 (*Martin*).

Molecular (MV) larvae. Queensland, 2L, Emerald Ck., 16°58.50'S 145°34.00'E, 8.ix.2007, 360 m a.s.l. (*Krosch*) (MV FNQDE1R, DE1.24); L, Atherton, Nigger Ck., 17°26'S 145°28'E, 1.ix.2005 (*Krosch*) (MVN7); 2L, Paluma, Birthday Ck., 18°58.35'S 146°09.26'E, 24.ix.2008, 700 m a.s.l. (*Krosch*) (MV FNQBC8R1-2); L, Paluma, Little Birthday Ck./ Camp Ck., 18°58'22"S 146°09'52"E, 850 m a.s.l., 21.ix.2008 (*Krosch*) (MV FNQC-C4R1); L(3i) same except 22.ix.2008 (MV FNQBC7R1), L, same except 21.ix.2008 (MV PAa2, 15); 2L, Cloudy Ck., 18°59.50'S 146°12.30'E, 25.ix.2008, 720 m a.s.l. (*Krosch*) (MV FNQCCR1, 2,3); 3L, Cooloolo N.P., Frankis Gulch, 26°02.50'S 153°04.44'E, 18.iv.2009 (*Krosch*) (MV AU09FG3, 4, 10). Northern Territory, 4L, Kakadu N.P., Burdulba Ck., 5.i.2007 (*Hanley et al.*) (MV NT11B1R1-4, all 3i) [possibly unknown larva of *R. kakadu*].

**Description. Male.** Thorax yellow, with distinct brown vittae (dark area may be restricted to anterior of median vitta and lateral edges of lateral vittae) and transverse pleural stripe. Legs with dark band on mid-femur, femoral apex, base, mid and apex of all tibia, apices of all tarsomeres (5th may be all dark). Wing membrane infusate, with transverse dark patch including both 'forks'. Abdomen with posterior third of tergite II with dark transverse band; all succeeding segments with dark postero-lateral areas, genitalia brown. Setae of TIX long, slender, arranged in two clusters, separated medially by non-setose strip. Gonostylus relatively short, not tapered at gonocoxite junction, bearing essentially simple setae, some with fine branches, all distally pointed. Superior volsella (Fig. 2B) without microtrichia in basal or medial area, proximo-laterally with 4–6 long setae, without posterior projection, medially-directed lobe-shaped digitus without microtrichia, with 7–12 simple seta, ending in narrowed lobe or notched; inferior volsella small, mainly appressed to inner contour of gonocoxite and linked to superior volsella, without pectinate scales, with long simple setae and dense microtrichiae extending from distal area linking to superior volsella. Pseudovolsella no more than weak bulge with strong setae not differentiated from linearly aligned on inner gonocoxite (Fig. 2B). Mensural features as in Table 1.

**Female** (n=3, part teneral). Colour similar to male, yellow with median vitta anteriorly brown oval, lateral vittae pale brown with darker outline anteriorly and laterally, extending from mid-scutum to just anterior to pale scutellum; central postnotum brown. anepisternum with broad brown linear 'smear'. Wing with infusate band over cross-veins, paler apically and at base. Legs with transverse band at 2/3 on forefemora, dark brown at distal apices of femora and proximal base of tibia ('knees'); tibial apices darkened near spurs; apices of tarsomeres brown; foreleg with darkest pigment, mid and hind legs less intense. B.L. 6.0 mm, W.L. 2.5 mm. Antenna flagellomeres 140–180, 105–115, 100–105, 95–100, 140–165; AR 0.32–0.34. 38–40 clyp, 16 multiserial orbitals. Palpomeres 50, 50–55, 170–300, 180–280, 260–360. Thorax. Ac ?–9, Dc 14, Pa 2–3, Scts 14–15. Wing V.R. 1.12. Vein setation: R 28–37, R<sub>1</sub> 24–34, R<sub>4+5</sub> 58–67; sq. 11–19. Leg lengths: P<sub>1</sub> 1400, 1440, 1440, 800, 640, 480, 220; P<sub>2</sub> 1560, 1380, 780, 440, 320, 200, 110; P<sub>3</sub> 1400, 1380, 940, 600, 420, 240, 120. Ratios: LR<sub>1</sub> 1.01, LR<sub>2</sub> 0.56, LR<sub>3</sub> 0.68; BV<sub>1</sub> 2.04, BV<sub>2</sub> 3.4, BV<sub>3</sub> 2.7; SV<sub>1</sub> 1.97, SV<sub>2</sub> 3.77, SV<sub>3</sub> 2.96. Foretibial comb, 50 with 5–6 lateral teeth each side; midtibials 65, 75, rear 65, 70, with strongly developed lateral teeth.

**Pupa.** Brown with dark dorsal thorax, anterior wing sheaths and lateral apophyses on all abdominal segments; comb brown-black. Cephalothorax with strong frontal warts, thorax rugose with multiserial rows of dark tubercles on dorsum. Hook row on II continuous [one exception, see remarks], occupying c 50% of tergite width. Conjunctival spinule bands on III–V narrowly separated to almost completely contiguous with posterior tergal armament, on V narrower and maybe medially sparse. Pedes spurii B absent, vortex strong. Abdomen (Fig. 3E): Tergite II with triangular area of spinules anterior to and narrower than hookrow, without any more anterior spinules, TIII–V largely infilled with spinules, TVI with anterior-median oval area, separated from posterior transverse band; TVII and VIII with anterior and posterior areas of fine spinules. Comb (Fig. 3J, 4I) variable, often with "windows" of pale cuticle within, with 1 strong, inner spine directed postero-medially and 3–4 subordinate spines.

**Larva.** Head capsule yellow including postmentum and genae, with dark occipital margin, mandible golden yellow, bases of inner 4 mandibular teeth and mental teeth golden-brown. Clypeus lozenge-shaped, elongate-ovoid,



3× as wide as long (Fig. 5A, 6E). Antenna (Fig. 5E) with 3<sup>rd</sup> segment longer than 2<sup>nd</sup>, characteristically narrowed basally and with thin wall on one side; segment 4 < 2/3rds length of segment 2 (14–18µ to 21–25µ). Ventromental plate variable, with specimens from Cloudy Ck 20% longer than mentum width, with all others close to 100%. Mensural features as in Table 2.

**Diagnosis.** Adults of *R. cinctipes* have distinctively ‘banded’ legs and pigmented wings, but both vary in intensity perhaps associated with tenability. Amongst the males of the 5 taxa with patterned-legs, geographic distribution and male genitalia provide discriminatory features. *Riethia cinctipes* is an eastern Australian species as is *R. stictoptera*, the others are from Western Australia or New Caledonia. The characteristic gonostylus of *R. stictoptera* differs from the conventional one of *R. cinctipes*. The digitiform appendage of the superior volsella, absent in *R. stictoptera*, differs in each of the other banded-leg species, see key and Figures 2B, 2C, 2G. Specifically, the medially-directed digitus has a notch or apical tooth on the anterior margin in *R. cinctipes* whereas the digitus tapers evenly to a point in *R. donedwardi*.

The pupa of *R. cinctipes* also resembles that of *R. stictoptera* with undivided hookrow and only conjunctives III and IV with continuous rows of spinules and with sparse spinules on the posterior of TII. The pupa of *R. cinctipes* lacks pedes spurii B and tergite II has a moderate-sized spinule area, about as wide as the hook row, in contrast to a smaller spinulose area in *R. stictoptera*. Some southern exuviae and those from N.T. have the conjunctival bands more distinctly separated from the tergal spinulation. None of these are reared, and for the present they are treated as variants of *R. cinctipes*.

Larvae of *R. cinctipes* have a low AR (<1.2) as does *R. donedwardi*, but the mentum and inner mandibular teeth are brown compared to the yellow-gold teeth in *R. donedwardi* which is a species restricted to Western Australia. The 3<sup>rd</sup> antennal segment is much longer than the 2<sup>nd</sup> but is subequal in *R. donedwardi* and also is narrowed, seemingly thinner-walled, medially (Fig. 5E). Further differentiation comes from the lozenge-shaped (elongate-ovoid) clypeus, 3× as wide as long.

**Remarks.** There is substantial variation in the setosity of the male thorax. For example, a reared male from 5-mile Creek has multiple rows of dorsocentrals, but unreared males from further north in Queensland have fewer near uniserially arranged. The ventromental plate with respect to the width of the mentum falls in to two classes: close to equal (ratio=1.0) or greater (ratio = 1.2 for same width of mentum). This partially conforms to variation seen in molecular barcode patterns—unfortunately only 1 specimen produced 4 genes.

**Distribution and ecology.** *R. cinctipes* is an eastern Australian species with a range extending from 13°S -14°S in Kakadu and Litchfield National Parks, Northern Territory and north Queensland, southwards to an isolated record from south coastal Victoria. Most reports are from the north to central parts of this range, with no specimens from Tasmania. Most sites are from running waters, but this habitat is over-represented due to use of drift nets in lotic conditions. Larvae do occur in billabongs and standing waters in rivers, usually with good to excellent water quality.

### ***Riethia donedwardi* Cranston sp.n.**

(Figs. 1A, 2C, 3F, 3K, 5F, 6F)

urn:lsid:zoobank.org:act:503ABEA4-741D-4577-B06A-9E36B1B2789B

*Riethia* ‘V4’, Cranston 1996; 2000.

**Type material.** **Holotype** Le/Pe/♂, AUSTRALIA, Western Australia, Deep River, 34°48'S 116°37'E, 13.x.1983 (*Edward*) (WAM), ANIC database #2187. Paratypes (collected Cranston, deposited ANIC, unless otherwise stated): Pe, nr Walpole, Deep R., 34°55'S 116°37'E, 4.xiii.1994; Pe, Deep River, drift, 21.iii.1989 (*Nolte*) (ZSM) [misassociated on same slide with male of *R. noongar*, *Zuordnung der Exuvie unsicher*]; 2L (3i) Shannon N.P., Fish Ck., 34°40'S 116°23'E, 24.xi.1995; 2Pe, Carey Bridge, Carey Brook, 34°25'S 115°47'E, 23.xi.1994, #2189-90; L, L/P, Le/Pe/♂, Le/Pe/♀, Carey Brook, 34°25'S 115°49'E, 16–19.viii.1996 (*Cranston & Judd*); 4L, 2 Pe, Foster Brook, ‘Loc S11#2’ [32°30'S, 116°02'E], 31.iii.1983 (*Bunn*) (WAM); L, Donnelly R., Vasse Highway xing, 22–23.xi.1995, 34°20'S 115°46', #2189-90; L, Wilson's Brook, 32°32'32"S 116°02'32"E, 28.ix.2011 (*Pinder*) (MV WAWBV4R8); Le/Pe/♂, Seldom Seen Brook, 32°15'S 116°04'E, 2.viii.1982; same except Le/Pe/♀, 17.xi.1983;

**Other material examined.** ♂, Kimberley, 4 km W. King Cascade, CALM site 26/3, 15°38'S 125°15'E, 12–16.vi.1988 (*Weir*). Unreared larvae (including failed MV); 4L, Forth R., 34°52'S 116°23', 5.xii.1994, #2198; 5L (3i), Boxhall Ck., 27.x.2008 (*Pinder*); 8L, Wilson's Brook, 32°32'32"S 116°02'32"E, 28.ix.2011 (*Pinder*); 4L, Serpentine Dam 2, 32°21'40"S 116°01'26"E, 10.ix.2008 (*Pinder*).

**Description. Male.** Thorax pale brown, without distinct vittae; legs with dark band covering femoral/tibial junction, tibial apex, apices of tarsomeres 1–3 and all of tarsomeres 4–5. Wing membrane unmarked. Abdomen yellow, with posterior third of all segments darkened; segment VIII and genitalia dark. Hypopygium (Fig. 1A) with TIX setae fine, long, evenly distributed; gonostylus narrower at gonocoxite junction, dilate at base, tapering to blunt point, bearing only simple setae. Superior volsella (Fig. 2C) proximally with 4 long setae at distal edge of microtrichiose region, posterior setose projection weakly developed, medially-directed subtriangular digitus antero-basally with sparse microtrichia, with 7 simple seta; inferior volsella well developed, basally appressed to inner contour of gonocoxite and linked to superior volsella, without pectinate scales, with many long simple setae. Without pseudovolsella, with distalmost seta of inner gonocoxite strong (Fig. 2C). Mensural features as in Table 1.

**Female.** Pigmented as male, AR 0.28, LR<sub>1</sub> 1.1.

**Pupa.** Yellow-brown with darker brown dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb yellow. Cephalothorax with smooth frons without warts, thorax rugulose with tubercles on dorsum. Abdomen (Fig. 3F) with hook row on II continuous, 40% width of tergite, with strong, wide conjunctival spinule bands on III–V, close to but separated from dorsal armament of preceding segment. pedes spurii B moderately developed on II, vortex large. Tergite II with triangular armament, without anterior spinules, TIII–V with dense spinules in-filling tergite, TVI with anterior-median oval area linked narrowly to posterior transverse band; TVII and VIII with faint areas of fine spinules. Comb (Fig. 3K) with 1 stronger, triangular spine slightly curved and directed posteriorly, 2–3 weaker spines. Anal lobe with 60–65 taeniae in disorganised +/- biserial row.

**Larva.** Head capsule yellow with postmentum and mandible golden yellow, mentum and inner mandibular teeth golden, and strong brown-black occipital margin. Clypeus (Fig. 6F) rhomboid with clypeal setae inserted close to lateral margins. Antennal pedestal modestly developed, with small outer spine but its value in diagnosis is limited as it is not visible in many specimens. Inner margin of mandible with 3 spines near mid-point of mola. Antenna (Fig. 5F) with low AR, 3<sup>rd</sup> segment subequal to or slightly longer than segment 2. Ventromental plate long, 1.25 width of mentum. Mensural features as in Table 2.

**Etymology.** The species epithet recognises the late Dr. Donald (Don) H.D. Edward, of Perth, Western Australia, who accompanied the author in the field, studied Chironomidae for 50 years, and loved and deeply understood the freshwater biota of Western Australia. The epithet should be treated as a noun in genitive case.

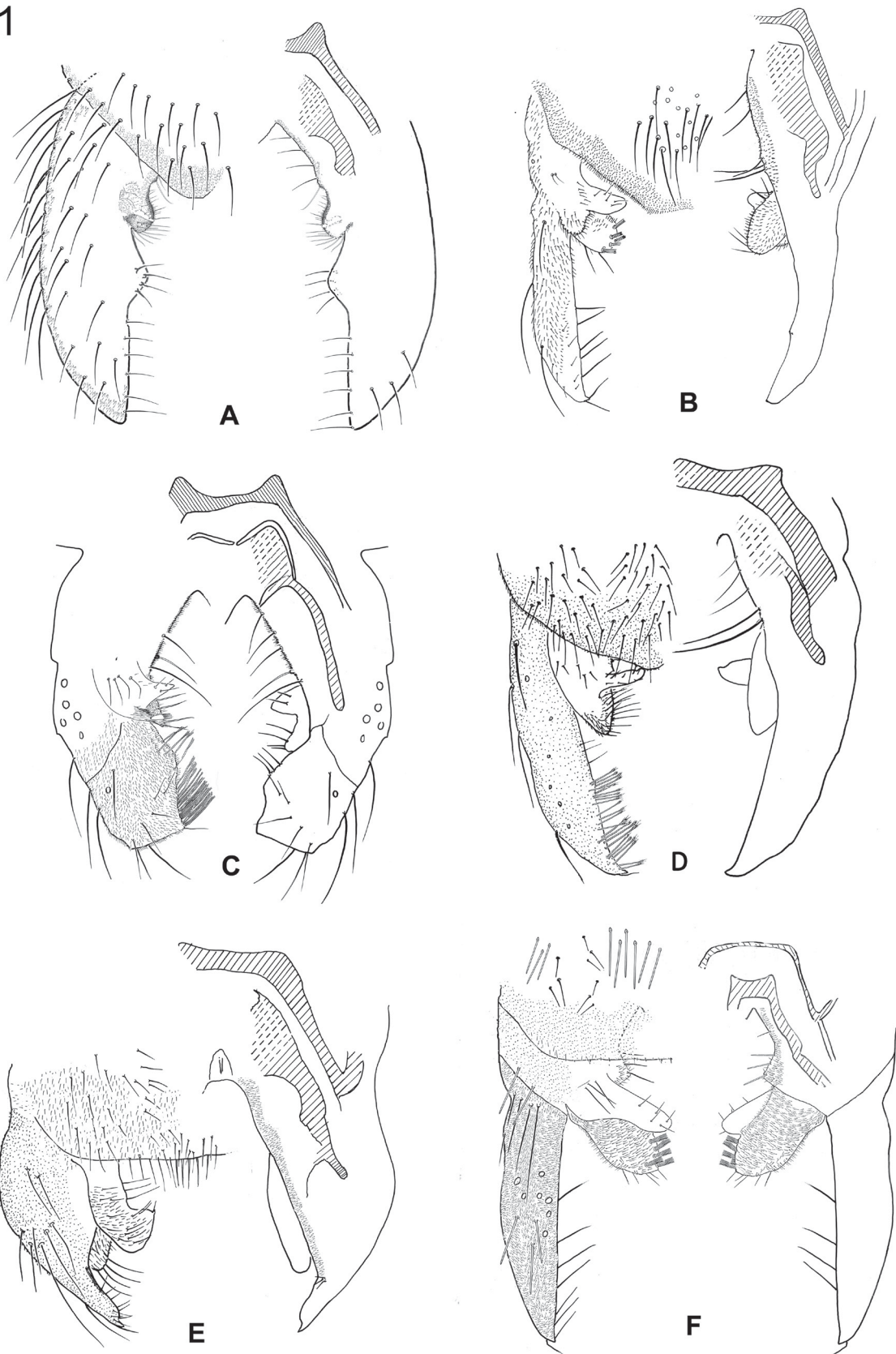
**Diagnosis.** The male of *R. donedwardi* is the only Western Australian *Riethia* with banded legs. The wing is unpigmented. In genitalic morphology the species most resembles *R. cinctipes*, the major difference being in the shape of the digitiform appendage of the superior volsella (Fig. 2B versus 2C). The regionally unique pigmentation applies to the female also.

The pupal exuviae of *R. donedwardi* is dark yellow verging on brown and has a continuous hookrow, and deep continuous conjunctival spine bands on III, IV and V. On V the conjunctival transverse band is broad, deep, and separate from the posterior spinule pattern of tergite V.

The larva of *R. donedwardi* has a golden mentum and inner mandibular teeth barely darker than the background golden-yellow colour. The antenna is unusual amongst all species of *Riethia* in having an AR close to 1 and with an antennal blade extending beyond the 5th segment.

**Distribution and ecology.** *R. donedwardi* is endemic to Western Australia with most records between 34° and 31°S with an outlier much further north, in the Kimberley. Larvae have been found in permanent creeks of low order in forested catchments.

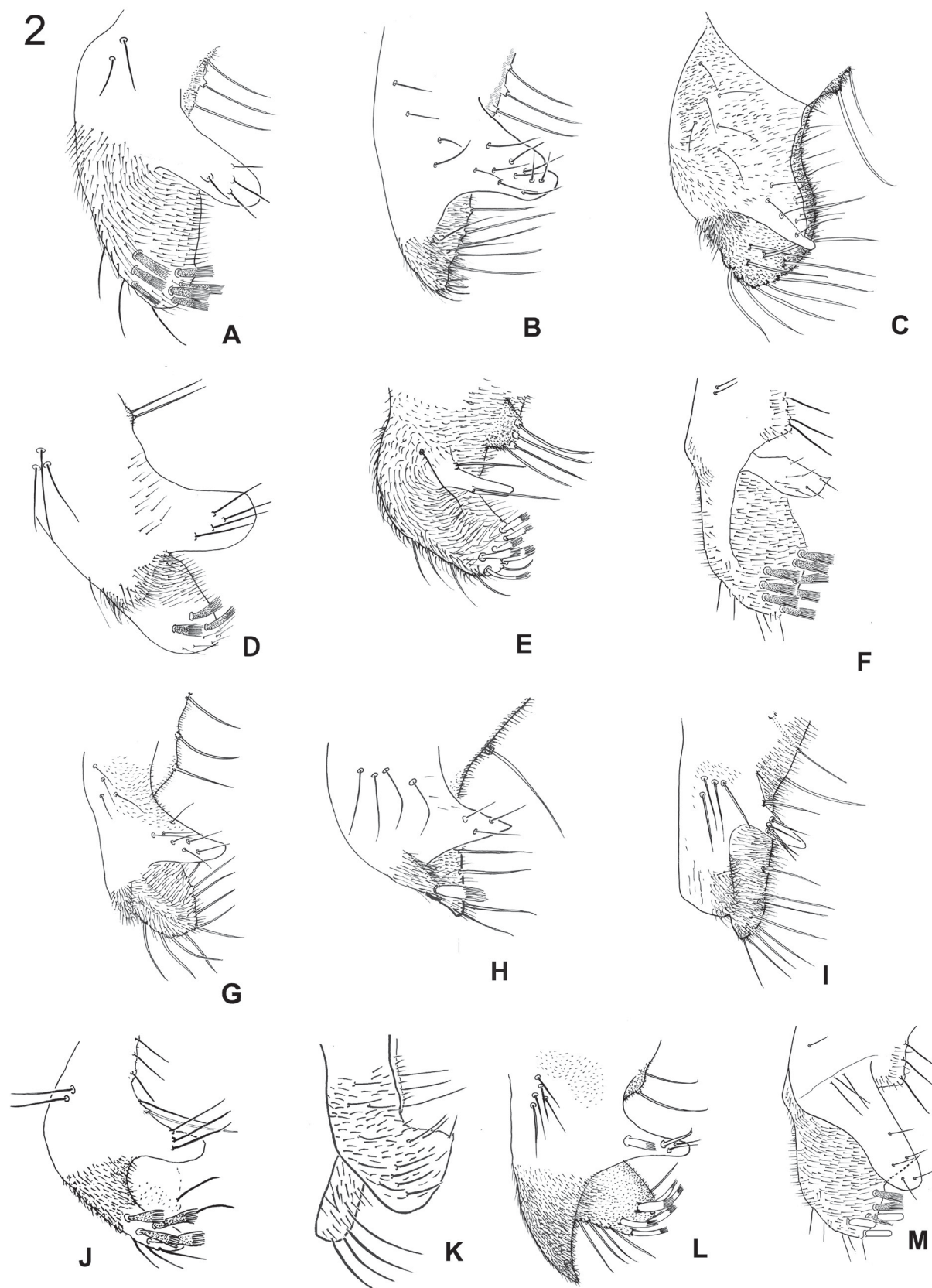
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**FIGURE 1.** *Riethia* spp. Male hypopygia L. side dorsal, R. side, ventral/internal, stylised: A. *R. donedwardi* **sp.n.**, B. *R. hamodivisa* **sp.n.**, C. *R. phengari*, **sp.n.** D. *R. plumosa* Freeman, E. *R. stictoptera* Keffer, F. *R. zeylandica* Freeman.



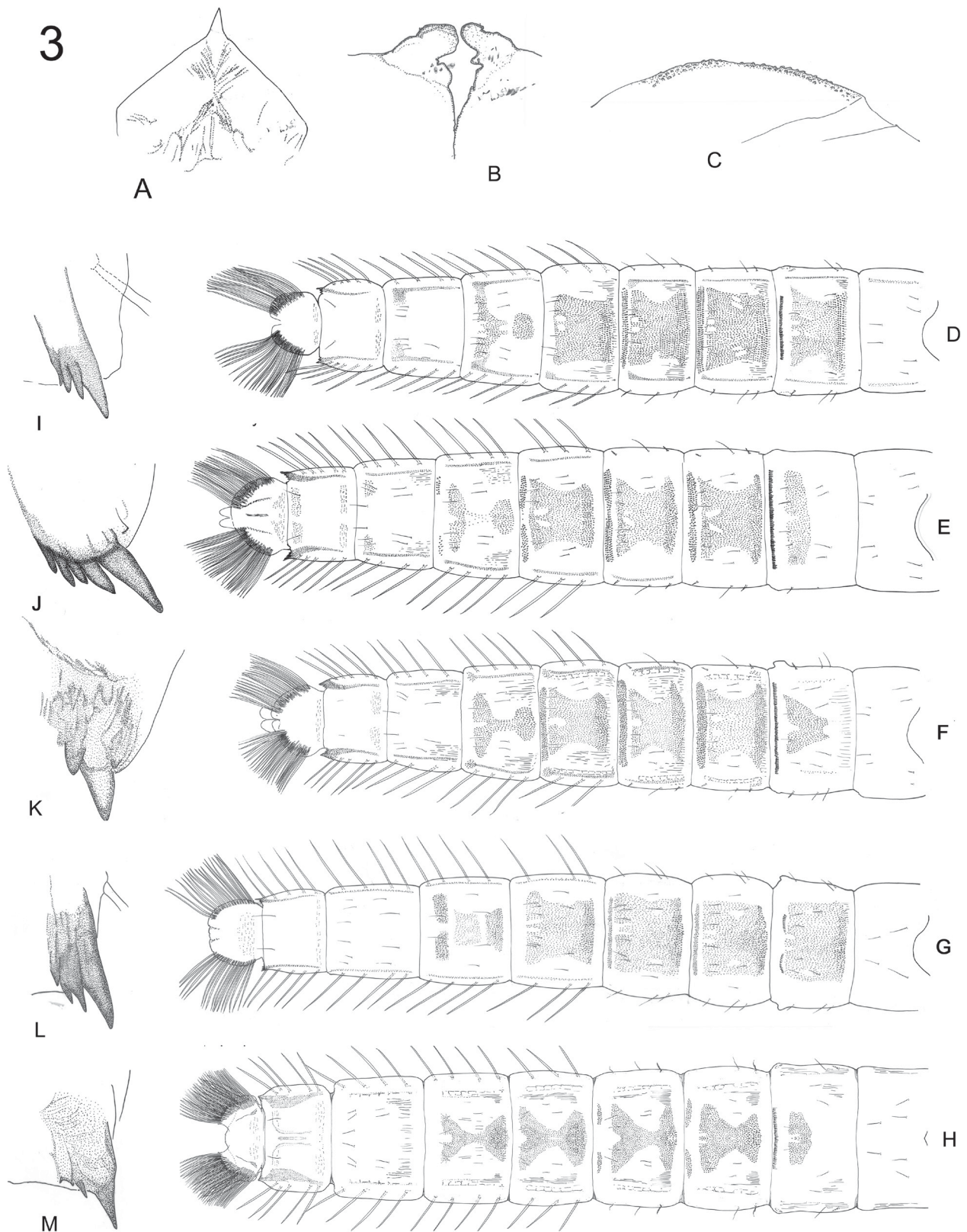
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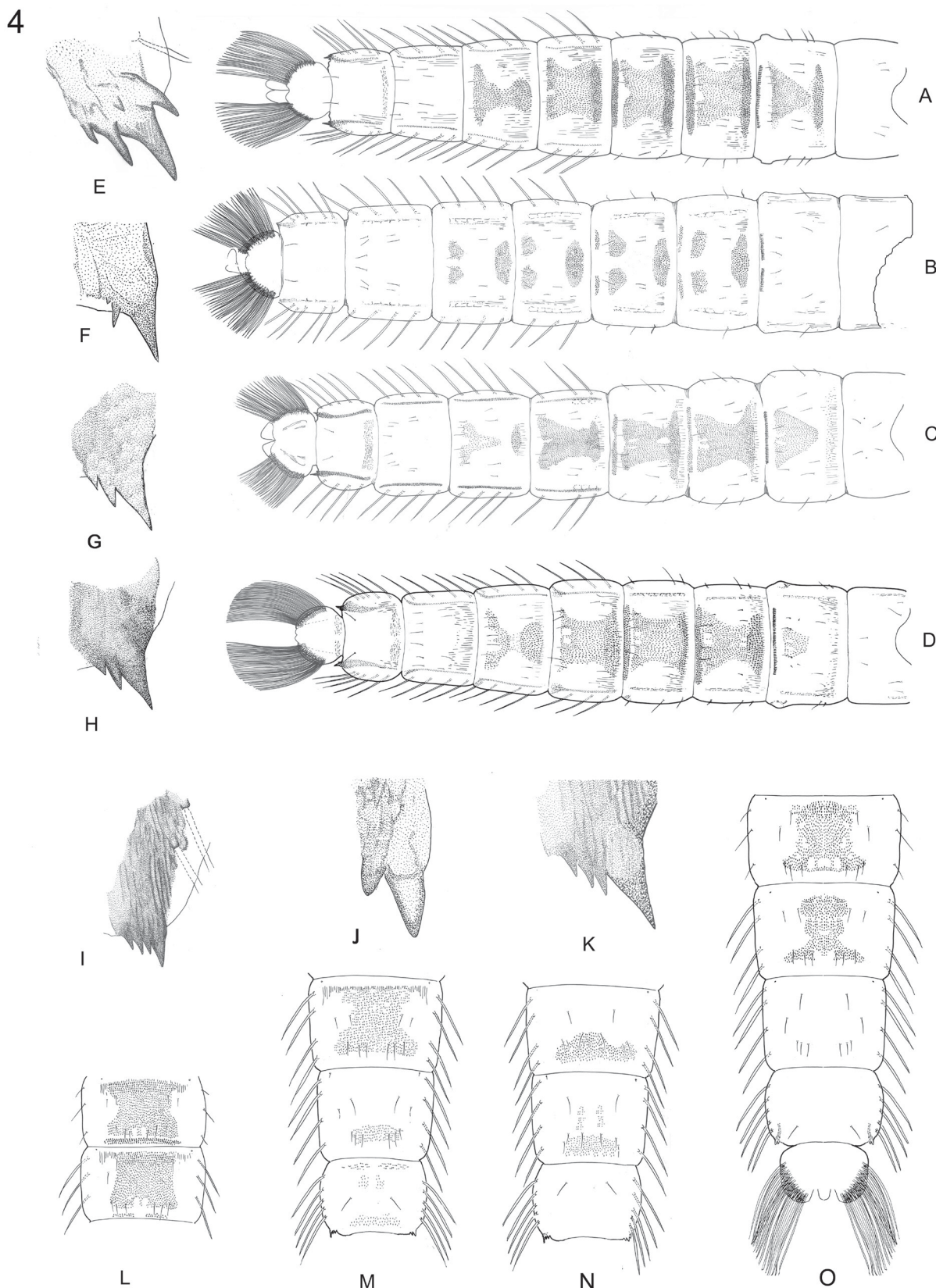
**FIGURE 2.** *Riethia* spp. Volsellae: A. *R. azeylandica* sp.n., B. *R. cinctipes* Freeman, C. *R. donedwardi* sp.n. D. *R. hamodivisa* sp.n., E. *R. kakadu* sp.n., F. *R. neocaledonica* sp.n., G. *R. noongar* sp.n., H. *R. phengari* sp.n., I. *R. plumosa* Freeman, J. *R. queenslandensis* sp.n., K. *R. stictoptera* Keffer, L. *R. wazeylandica* sp.n., M. *R. zeylandica* sp.n.



3

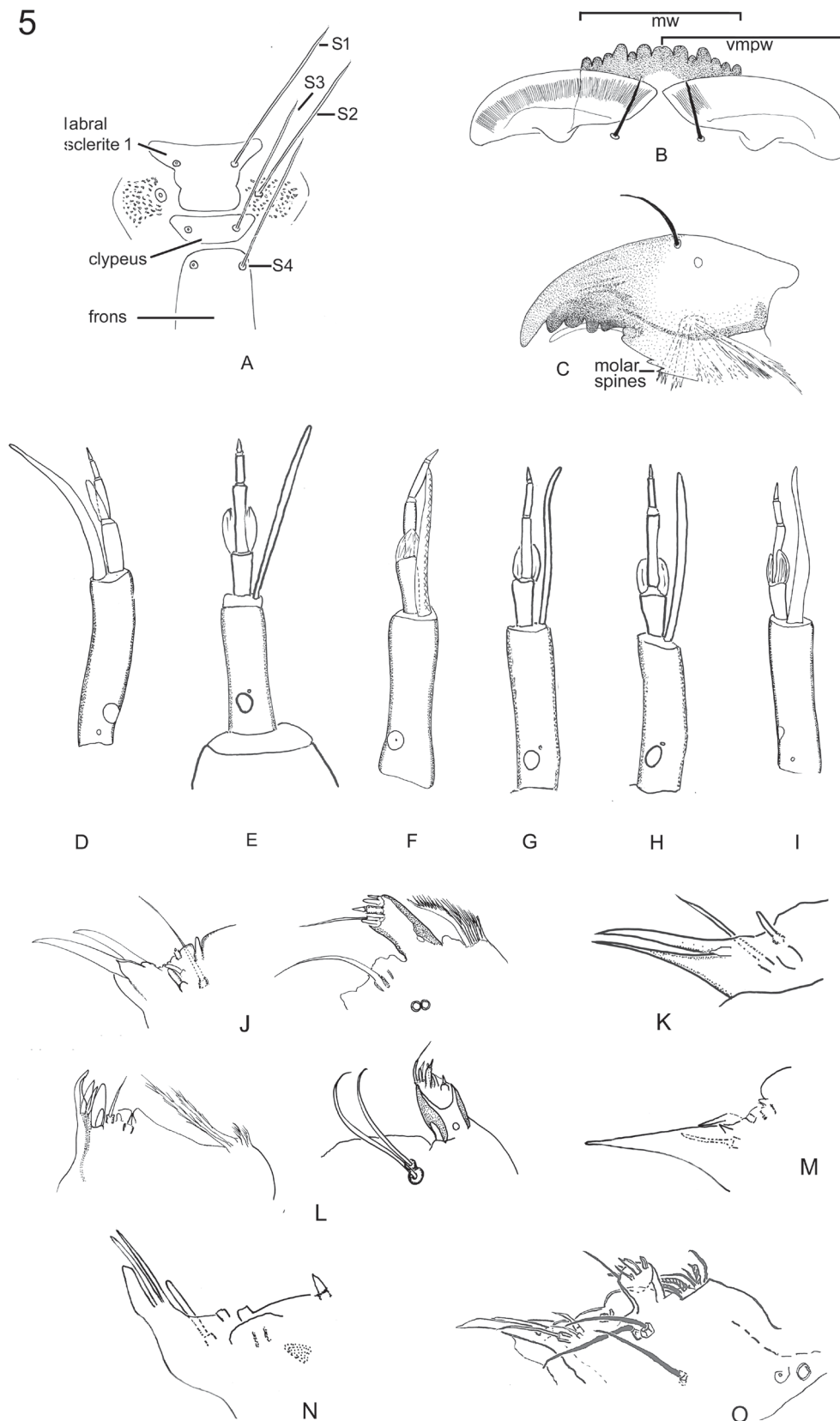


**FIGURE 3.** *Riethia* spp. Pupa. Cephalic tubules: A. *R. azeylelandica* **sp.n.**, B. *R. noongar* **sp.n.**, C. Dorsal thorax *R. kakadu* **sp.n.**. Abdominal tergites: D. *R. azeylelandica*, E. *R. cinctipes* Freeman, F. *R. donedwardi* **sp.n.**, G. *R. hamodivisa* **sp.n.**, H. *R. kakadu*. Posterolateral corner of VIII ('comb'): I. *R. azeylelandica* **sp.n.**, J. *R. cinctipes*, K. *R. donedwardi*, L. *R. hamodivisa*, M. *R. kakadu*.



**FIGURE 4.** *Riethia* spp. Pupa. Abdominal tergites: A. *R. noongar* **sp.n.**, B. *R. paluma* **sp.n.**, C. *R. plumosa* Freeman, D. *R. stictoptera* Kieffer. Posterolateral corner of VIII ('comb'): E. *R. noongar*, F. *R. paluma*, G. *R. plumosa*, H. *R. stictoptera* I. *R. cinctipes* (var), J. *R. phengari* **sp.n.**, K. *R. neocaledonica* **sp.n.**. Tergites: L, IV-V of *R. neocaledonica* ; M. Tergites VI-VIII of *R. queenslandensis* **sp.n.**, N. Sternites VI-VIII *R. queenslandensis*, O. Tergites V-AL of *R. zeylandica*.

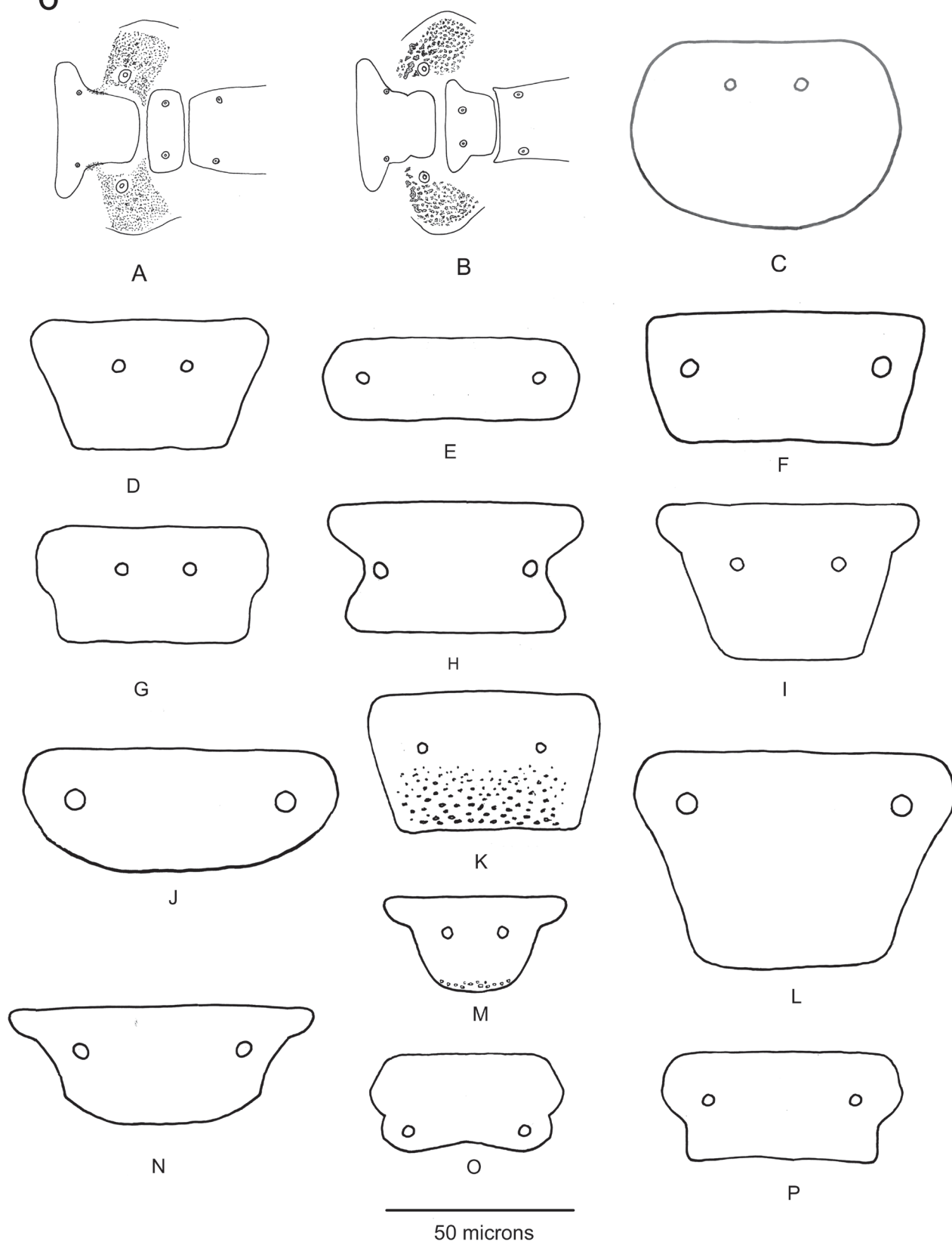
5



**FIGURE 5.** *Riethia* spp. Larva. A. Dorsal head, *R. cinctipes* Freeman; B. Mentum, *R. stictoptera* Kieffer; C. Mandible, *R. stictoptera*. D-I. Antenna, D. *R. azeylelandica* **sp.n.**, E. *R. cinctipes* Freeman, F. *R. donedwardi* **sp.n.**, G. *R. neocaledonica* **sp.n.**, H. *R. larval* sp. 'B'; I. *R. stictoptera*. Maxilla, J. *R. neocaledonica*, K. *Pseudochironomus* sp., L. *Aedokritus coffeatus* Trivinho-Strixino, M. *Manoa pahayoakeensis* Jacobsen & Perry, N. putative *Megacentron* Freeman, O. *Manoa obscura* Fittkau.



6



**FIGURE 6.** *Riethia* spp. Larva. Mid-dorsal head: A. *R. donedwardi* **sp.n.**, B. *R. noongar* **sp.n.**. Clypeus: C. *R.* larval sp. 'C', D. *R. azealandica* **sp.n.**, E. *R. cinctipes* Freeman, F. *R. donedwardi* **sp.n.**, G. *R. hamodivisa* **sp.n.**, H. *R. neocaledonica* **sp.n.**, I. *R. noongar* **sp.n.**, J. *R. paluma* **sp.n.**, K. *R. phengari* **sp.n.**, L. *R. plumosa* Freeman, M. *R. queenslandensis* **sp.n.**, N. *R. stictoptera* Kieffer, O. *R. wazeylandica* **sp.n.**, P. *R. zeylandica* Freeman.



***Riethia hamodivisa* Cranston sp.n.**

(Figs. 1B, 2D, 3G, 3L, 6G)

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*Rietha* 'divided hookrow' Cranston 1966, 2000

**Type material. Holotype** Le/Pe/♂, AUSTRALIA, Australian Capital Territory (ACT), Brindabellas, Blundells Ck., 26.iii.1988, 35°22'S 148°50'E, .ix.1998 (*Cranston*).

Paratypes (collected Cranston, deposited ANIC, unless otherwise stated): P♀, as Holotype except 26.iii.1988; Le/Pe/♀, 8.xi.1995, ex-wood (*McKie*); Pe/♂, Black Mt., pool, 13.i.1988; P♂, Victoria, Tambo R., 'USWW' (*Hortle*).

**Other material examined.** New South Wales: Pe, Micalong Ck., 35°17'29"S 148°31'56"E, 4.i.2001; 2Pe, Kosciusko N.P., Yarrangobilly, Yarrangobilly R., 35°39'S 148°28'E, 14–15.i.1991.

ACT: numerous Pe, Brindabellas, Blundells Ck., and Lees Ck., 35°22'S 148°50'E, Victoria, Tambo, 2P♀, Currawong Ck., 36°48'S 147°54'E, 11.xii.1990 (*Hortle*); numerous Pe & P♂, Tambo R., several sites, 1990–1991 (*Hortle*); Pe, Bindi Ck., 37°08'S 147°51'E, 29–30.xii.2000 (*Cranston & Gullan*).

Tasmania: Pe, 41°50'S 146°00'E, Cradle Mt.-L. St. Clair N.P., Frog Flat, 25.i.1990.

Unreared pupae and larva, excluded from paratype series. Pe, Queensland, Mt Lewis, Windmill Ck., 16°34'S 145°16'E, 8–9.ix.1997 (*McKie*); Pe, nr Mareeba, Davies Ck., 17°01'S 145°35'E, 19–20.vi.1997. L., ACT, Corin, Gibraltar Falls, 35°28'S 148°55'E, 30.i.2001.

**Description. Male.** Thorax pale yellow, with deeper yellow vittae; legs pale without banding. Wing membrane unmarked, veins yellow. Setae of TIX fine, in median cluster. Hypopygium (Fig. 1B) with gonocoxite slightly narrowed at junction with gonostylus, gonostylus apically tapered but without distinct tooth, bearing only simple setae. Superior volsella (Fig. 2D) predominantly without microtrichia, with 3 long setae anterolateral setae, posterior setose projection weak and continuous with inferior volsella, with medially-directed broad, apically rounded digitus with band of setae across base, otherwise devoid of microtrichia, with 3–4 simple setae. Pseudovolsella 2 long approximated setae, without tubercle (Fig. 2D). Inferior volsella well developed, basally appressed to inner contour of gonocoxite and linked to superior volsella, with 6–7 pectinate scales and many long simple setae. Mensural features as in Table 1.

**Female.** Pigment as male. AR 0.38, LR not measureable.

**Pupa.** Very pale with darker yellow dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb yellow. Frons with weak warts, cephalothorax weakly rugulose with several rows of dorsal tubercles. Hook row on II with wide medial interruption; with continuous conjunctival spinule band on III and IV. Pedes spurii B weak, vortex weak. Abdomen (Fig. 3G) with tergite II with rectangular-shaped armament pattern, quite dense, with anterior transverse band not delimited either by size or density, TIII–V well filled with spinules, TVI with anterior-median elongate/oval area, separated by microspinules median area from posterior transverse band of stronger spinules; TVII and VIII bare. Taeniate setae 3, 4, 4, 5, on VIII evenly distributed along segment. Comb (Fig. 3L) with 1 strong posteriorly-directed spine and 2 weaker inner spines. Anal lobe with 20–32 uniserial taeniae.

**Larva.** Head capsule pale yellow with dark occipital margin, mandible golden yellow, mentum and inner 4 distinct mandibular teeth golden. Clypeus (Fig. 6G) dilate anteriorly, squared off posteriorly with straight posterior margin; clypeal setae inserted towards centre. Mandible with broad spine beside insertion of seta subdentalis, with 2 serrations on mola. Antennal ratio 1.4, with each segment shorter than preceding. The mentum usually is 10% longer than the width of a ventromental plate. Mensural features as in Table 2.

**Etymology.** Based on Latin *hamus*—hook and *divisa*—divided, referring to the unusual median division of the transverse row of hooklets on the posterior of tergite II.

**Diagnosis.** The adult male of *R. hamodivisa* is identifiable solely on minor differences in the hypopygium, notably the inferior volsella with digitus lacking any pectinate scale and the distal area bare, with 3 pectinate scales. The pupa has the hookrow on the posterior of tergite II widely divided medially into two parts (see remarks below), with dense armament on TII and III. The larva has an AR > 1.4, the mentum and all mandibular teeth golden-yellow (as head capsule) and the clypeus c. 55 x 32µm, with clypeal setae positioned medially.

**Remarks.** This taxon was recognised as distinct from '*R. zeylandica*' first from a pupa with a hookrow on the

posterior of tergite II widely divided medially into two parts. Adult males (including examined pharates) differed from '*R. zeylandica*' in the volsellae of the male genitalia. Subsequently in associated larvae the dorsal head sclerites (Fig. 6G) differentiate. Only teneral or pharate (non-emerged) adults are available for description.

A second species with a divided hookrow is *R. paluma* sp. n. (Fig. 4B, F), known from a single reared female only, but it is clearly differentiated in the pupa by the divided conjunctival bands on II and IV, and the absence of armament on TII, and very reduced armament on TIII–VI.

A divided hookrow occurs also in two exuviae from far north Queensland, one from Windmill Creek, another from Davies Creek. Both exuviae have complete but narrow conjunctival spinule bands, and have well developed armament on TVII unlike the nearly bare TVII of *R. hamodivisa* (Fig. 3G), and are excluded from the type series of *R. hamodivisa*.

**Distribution and Ecology.** *R. hamodivisa* seems to be restricted to south-eastern Australia, from southern NSW and ACT, through eastern Victoria and with a solitary specimen from Tasmania. Records range from near pristine submontane creeks to more polluted creeks in dairy-farming country. A rearing from Black Mountain, Canberra, is the only record from standing water. Two exuviae from streams in north Queensland tablelands, if belonging to *R. hamodivisa*, would be a significant extension to the range.

### ***Riethia kakadu* Cranston sp.n.**

(Figs 2E, 3C, H, M)

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*Riethia* K1 Cranston 1996; 2000.

**Type material.** **Holotype** ♂, AUSTRALIA, Northern Territory, Kakadu N.P., Radon Spring, 12°45'S 132°55'E, 13–14.iv.1989 (Cranston) #2206 (ANIC). Paratypes: 3♂, as holotype; ♂, Kakadu N.P., Coronation Hill, S. Alligator R., 13°35'S 132°26'E, 4–5.vi.1988; ♂, Western Australia, Kimberleys, Adcock Gorge, 35 km SW Mt. Barnett, Gibb River Rd. [16°55'S 125°46'E] *Eucalyptus camuldulensis*, 'Lux', 13–14.8.1995, leg. M. Baehr (ZSM).

**Other material** (collected Cranston, deposited ANIC, unless otherwise stated, Pe excluded due to association by co-location only): 4Pe, as holotype, 3Pe as holotype except 6.vi.1988; Pe, Litchfield National Park, Petherick's Rainforest, 13°07'S 130°39'E, 6.viii.1990; Pe, Coronation Hill, S. Alligator R., Gimbat spillway, 13°34'S 132°35'E, 19–20.iv.1989; 2Pe, 13°10'S 130°41'E, Litchfield Park, Wongi Falls, 6.viii.1990; Pe, Koolpin Gorge, 13°30'S 132°35'E, 15/16.v.1992, #2213; Pe, Katherine Gorge, below gorge #1, 14°20'S 132°25'E, 21–22.v.1992; Pe, same except gorge #1, 14°18'S 132°26'E, 21.v.1992.

Identified on morphology as *R. cinctipes*, but possibly *R. kakadu*: Northern Territory, 4L, Kakadu N.P., Burdulba Ck., 5.i.2007 (Hanley *et al.*) (MV NT11B1R1-4, all 3i).

**Description. Male.** Thorax yellow, with vittae weakly indicated as darker yellow; legs pale, without banding or with slight darkening of subapical femora. Wing membrane unmarked, veins pale. Setae of TIX fine, long, covering tergite. Gonostylus not broadened at junction with gonocoxite, which bears only simple setae. Superior volsella (Fig. 2E) covered in microtrichia with 1 long seta near base of digitus, posterior projection well developed, setose, melding into inferior volsella; digitus medially-directed, narrow, apically rounded, devoid of microtrichia, with 2 long simple setae, 1 towards base, 1 nearer apex; inferior volsella strong, with 5–7 pectinate scales and several simple setae. Pseudovolsella a strongly protruding tubercle with 3–4 proximated long setae (Fig. 2E). Mensural features as in Table 1.

**Female** unknown.

**Pupa** (putative). Mid-brown, with darker brown dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb brown. Cephalothorax rugulose with multiple rows of small tubercles along line of eclosion (Fig. 3C). Abdomen (Fig. 3H) with uninterrupted hook row occupying 40% of tergite width, conjunctival spinule bands on III and IV medially interrupted; pedes spurii B well developed; vortex strong. Tergite II with armament restricted to small triangular area anterior to hook row, without any indication of anterior transverse band, TII–VI with hour-glass shaped armament, TVII with strong anterior creases terminating without spinule; TVIII with microspinules anteriorly. Taeniate setae 3, 4, 4, 5, on VIII L<sub>3–5</sub> clustered. Comb (Fig. 3M) with 1 stronger spine, 2–3 weaker posteriorly-directed spines. Anal lobe with 45–50 +/- biserial taeniae.

**Larva** unknown.

**Etymology.** From the main location, Kakadu, the federally managed national park. To be treated as a noun in apposition.

**Diagnosis.** The adult male has only simple setae on the gonostylus and the superior volsella, lacks pectinate scales. The digitus of the superior volsella lacks pectinate setae and seems characteristically narrow from the base, bearing only 1 inner and 1 outer seta. The pupa, which is associated only by co-occurrence, has an undivided hook row, lacks a conjunctival band on TV, and has the conjunctival rows on III and IV clearly divided medially.

**Remarks.** No molecular data are available: specimens collected for the project did not produce DNA.

**Distribution and Ecology.** *R. kakadu* is known from northern Australia, in the areas of seasonal monsoonal rainfall. Most specimens have been collected in Kakadu and Litchfield National Parks which preserve some of the best quality waterways in northern Australia.

### ***Riethia neocaledonica* sp.n.**

(Figs 2F, 4K,L, 5G, 6H)

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**Type material. Holotype** ♂, slide mount, Euparal, NEW CALEDONIA, S. Prov., Mt. Mou, road xing, 22°04'S 166°20'E, c 200 m a.s.l., 26.i.2003 (*P.S. Cranston*). Paratypes (collected Cranston, deposited ANIC, unless otherwise stated, all slide mounted) 1Pe/♀, 13Pe, 3 L(P), 6L, as holotype; 4Pe, N. Prov., N. La Foa, 20°29'S 165°48'E, 1.ii.2003; Mt. Panié, refuge, 500 m a.s.l., 5.xii.1990 '#90.285' (*M. Baylac*) (MNHN); ♂, 'For Inf Mt Mou / 200 250 m., M B Ruiss / Muséum Paris / Nouvelle Calédonie / Exped L. & D. Matille, nov. dec. 1983' 16.ix.1983 (*L. & D. Matile*) (MNHN); 4Pe, L, Mt. Khogis, cascades, 22°09'S 166°32'E, c. 500 m a.s.l., 28.i.2003; 10♂, 6♀, c. 300 m. S. Koghis restaurant, 22°10'58"S 166°30'6"E, 417 m a.s.l., 16–26.xi.2003 (*Johanson via Espeland*), includes **MV NCALR3**.

**Description. Male.** Thorax yellow with dark vittae, scutellum and especially postnotum. Legs banded, with distal apices / subapices of femora, tibiae and much of each tarsomere darker brown on yellow. Wing faintly brown including around yellowish veins, but without bands. Tergites yellow with brown transverse bands on posterior of TII–V, VI pale, VII, VIII and hypopygium darkened. Tergite IX medially with cluster of 10–12 broad strong setae, 1.5–2x usual width of TIX setae. Gonostylus merges evenly into gonocoxite which tapers gradually to terminal small hook, with only simple setae. Digitus of superior volsella narrow at base then more dilate bearing 7–9 small simple setae (Fig. 2F). Pseudovolsella angular projection with 3 long setae (Fig. 2F). Inferior volsella bare at base, apically with 5–6 short apically pectinate setae and 3 longer flattened scales. Mensural features as in Table 1.

**Female.** Pigmented as male, AR 0.3, LR<sub>1</sub> 1.0.

**Pupa.** Darkened with brown thorax including veins and margins of wing sheath and all apophyses. Frons with small warts. Thorax densely and broadly rugulose with several rows of dorsal tubercles. Abdomen with continuous hook row 50% of tergite width, and broad conjunctival spinule bands on III, IV and on V, thinner, narrower band of spinules, well separated from posterior tergal spinules (Fig. 4L). Pedes spurii B very weak. vortex well developed. Tergal spinule pattern closely resembling that of *R. stictoptera* (Fig. 4D) notably in lack of anterior spinules on TII, differentiated anterior and posterior stronger spinules on TII–VI (Fig. 4L), and in the spinulation of TVII, VIII and anal lobe. Taeniate setae V–VIII 3, 4, 4, 5; L<sub>3–5</sub> on VIII somewhat clustered, with respect to L<sub>1–2</sub>. Comb (Fig. 4K) with one strong tooth, 3-much smaller inner teeth. Anal lobe fringe dense with 35–40 uni- biserially inserted taeniae.

**Larva.** Head capsule evenly golden-yellow with broad and dark postoccipital margin; mentum and inner mandibular teeth distinctly golden brown with apical mandibular tooth golden, long and curved. Clypeus (Fig. 6H) c. 2x as wide as long (70 × 32 µm), with strongly indented lateral margins and S3 setal bases aligned with innermost point of the lateral contour, close to lateral margin (Fig. 6H). Dorsal sclerite broadly flared anterior to S2 setae. Antenna (Fig. 5G) ratio low at 1.1–1.2; 2<sup>nd</sup> segment shorter than 3<sup>rd</sup>; walls of segment 3 notably thinner than others; segment 4 at least 80% length of segment 2. The ventromental plate is very similar to slightly shorter than the width of the mentum. Mensural features as in Table 2.

**Etymology.** From adjectival *caledonica* from *caledonia*, the roman name for current day Scotland, probably from celtic. The 'neo' refers to James Cook's (fanciful) belief in the resemblance of the island of New Caledonia to Scotland.

**Diagnosis.** The species is endemic to New Caledonia. The male with banded legs, ‘conventional’ shaped gonostylus, digitus of superior volsella narrow at base then more dilate, and inferior volsella with pectinate setae is distinctive. In the pupa, the narrow transverse and medially interrupted band of spinules on conjunctive V, well separated from posterior tergal spinules (Fig. 4L), is unlike any other species. Generally the pupa resembles that of *R. stictoptera* (Fig. 4D) but the intensity of pigment and the interrupted conjunctival band on V distinguishes. The larva is distinguishable by antennal features (ratios) and the clypeus shape.

**Remarks.** The life history association comes from L(P) and P(♀) and being the sole species in New Caledonia.

**Distribution and Ecology.** *Riethia neocaledonica* is endemic to the island of New Caledonia where it occurs in low order streams, although apparently not in lateritic areas.

***Riethia noongar* Cranston sp.n.**

(Figs. 2G, 4A, 4E, 6B, J)

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*Riethia* ‘V5’, Cranston 1996; 2000.

**Type material. Holotype** Le/Pe/♂, AUSTRALIA: Western Australia, Mitchell R., 34°50'S 117°25'E, 3.xii.1994 (Cranston) (ANIC). Paratypes (collected Cranston, deposited ANIC, unless otherwise stated): Western Australia: 2Pe, Denmark R., 34°52'S 117°16'E, 3.xii.1994, #2205; 2Pe, Shannon N.P., Fish Ck., 24.xi.1994; ♂, Deep River, drift, 34°48'S 116°37'E 21.iii.1989 (Nolte) (ZSM) [misassociated on slide, with pupa of *R. donedwardi*, *Zuordnung der Exuvie unsicher*]; Pe, lower Shannon R., 34°39'S 116°22'E, 23–24.xi.1994; Pe, lower Shannon R., 34°51'S 116°22'E, 5.xii.1994; Le/Pe/♂, Le/Pe/♀, Wungong Catchment, Seldom Seen Brook, 32°15'S 116°04'E, 26.viii.1982 (Edward / Bunn) (WAM).

**Other material.** Western Australia, L, Chesapeake Rd., lower Shannon R., 34°51'S 116°22'E, 5.xii.1994, #2204; L, Big Brook, 32°52.53"S 116°06.20"E, 7.x.2009 (Pinder) MV **MRY09R3**); 2L, ‘loc 543’, 3.v.1983, unknown collector.

**Excluded: material of molecular-diagnosed sister to *R. noongar*.** New South Wales, L(?3i), Glenbog SF., Brown Mt., Fastigata Rd., Rutherford Ck., 36°36'S 149°47'E, 909 m a.s.l, 4.ii.2009 (MV **NSWRGCR9**); L(3i, damaged), same except 27.xi.2010 (MV **NSWBMR1**); ♂ (damaged in extraction) Koskuszko N.P., Charlotte's Pass, Spencer's Ck., 36°26'04"S 148°20'17" 1.xii.2010 (MV **NSWKOS25AR1**).

**Description. Male.** Thorax yellow-brown, without distinct vittae; legs pale without banding, abdomen may be dark brown. Wing membrane unmarked. TIX setae thin, long, in dense cluster across tergite. Gonostylus broadened at base, bearing simple and weakly plumose setae. Superior volsella (Fig. 2G) microtrichiose, with 4–5 scattered setae, posterior setose projection scarcely detectable, medially-directed part sub-triangular with very short digitiform extension, with 5–7 simple seta; inferior volsella large, posteriorly fused with superior, without pectinate scales, with many long simple setae. Inner gonocoxal setae strong, each of 3 distalmost arising from tubercle (Fig. 2G). Mensural features as in Table 1.

**Female.** Pigmented as male, AR 0.3, LR<sub>1</sub> 1.06.

**Pupa.** Pale with yellow dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb yellow. Cephalothorax weakly rugulose, with well-developed frontal warts (c. 50–60 µm long), bulbous to almost pyramidal-shaped (Fig. 3B), dorsum tuberculose. Abdomen (Fig. 4A) with uninterrupted hook row on II, 40–45% width of tergite; conjunctival spinule bands on III and IV. Pedes spurii B absent, vortex strong. Tergite II with anterior transverse patch of spines, almost disconnected from triangular mid-posterior patch, posterior width as hookrow, TIII–V with strong anterior spinules and rectangular medioposterior area, TVI spinule patch hour-glass shaped, TVII and VIII essentially bare. Anterior transverse band spines distinctly stronger and denser on II–V than more posterior tergites. Comb (Fig. 4E) with 1 stronger, triangular spine projecting postero-laterally, 2–3 weaker, also postero-laterally directed spines. Anal lobe with 22–30 unevenly biserial taeniae.

**Larva.** Head capsule yellow with strong brown occipital margin, postmentum and mandible golden yellow, mentum and inner mandibular teeth brown (innermost 4<sup>th</sup> incompletely separated from mola). Clypeus (Figs 6B, J) variably trapezoid with clypeal setae in anterior 1/3. Inner margin of mandible with broad lobe beside insertion of seta subdentalis and 2 strong spines near mid-point of mola. Antenna with short pedestal (25–30 µm), AR less than



1.5, and each antennal segment shorter than that preceding. The ventromental plate is very short, only 80% of the mentum width. Mensural features as in Table 2.

**Etymology.** Named for the noongar, aboriginal inhabitants of south-western Western Australia for the past tens of thousands of years. The traditional lands of the noongar community are substantially congruent with the range of this taxon. To be treated as a noun in apposition.

**Diagnosis.** The adult male of *R. noongar* has unbanded legs, gonostylus with only simple setae, and superior volsella and inferior volsella with only simple setae (i.e. lacking pectinate setae on the hypopygium).

The pupa of *R. noongar* has a continuous hookrow, and continuous conjunctival spine bands on only III and IV, with V bare. Tergite II is broadly spinulose, with a postero-median spinule area extending anteriorly to a broad transverse spinule area. The tergites are pale with apophyses indistinctly delimited. The cephalic area has smooth warts that taper, and TVII and all sternites are essentially bare.

The larval mentum and inner mandibular teeth are distinctly dark (brown) relative to the golden head colour. The antenna has the 3<sup>rd</sup> antennal segment shorter than the 2<sup>nd</sup> and the AR is less than 1.5.

**Remarks.** Molecular data demonstrate that the only successfully sequenced *R. noongar* differs by 12% from a small cluster of specimens from eastern Australia (see above). These combined form a sister to a substantial group including *R. queenslandensis* and *R. azealandica*, phylogenetically distant from the New Zealand *R. zeylandica*. This sister group to *R. noongar*, known informally previously as ‘eastern V5’, occurs as larva at the well-sampled Rutherford Creek. The larval MV NSWGCR9 seems to be a 3<sup>rd</sup> instar and a tentatively conspecific (non-MV) 4<sup>th</sup> instar indicate that the clypeus is a very similar shape to that of *R. noongar* (Fig. 6I), but the antennal pedestal is well developed and ventromental plate subequal to the width of the mentum (rather than c 80% (Table 2 ‘noongar’ v ‘sister to noongar’). The 3<sup>rd</sup> specimen in the clade is an adult male (also badly damaged) from high elevation in Kosciuszko N.P. The poor quality and shortage of critical specimens in ‘sister to *noongar*’ precludes description although very likely a new species.

**Distribution and ecology.** *Riethia noongar* is endemic to south-western Western Australia, from 32°S to 35°S. This area, known colloquially as the ‘jarrah belt’, supports ‘relictual’ aquatic organisms (Bunn *et al.* 1986; Edward 1989).

### ***Riethia paluma* Cranston sp. n.**

(Fig. 4B, 4F; 6J)

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**Type material.** **Holotype** Le/Pe/♀, AUSTRALIA, Queensland, Paluma, Birthday Ck., 800 m a.s.l., 18°48’S 146°09’E, 24.x.1998 (*McKie*) (ANIC).

**Description.** **Male** unknown.

**Female.** Colour (teneral) median vitta an anterior brown oval area, with lateral vittae brown, extending from mid-scutum to just anterior to scutellum; scutellum pale, postnotum brown, anepisternum with broad brown ‘smudge’. Wing pale at base, infusate from cross-veins to apex. Legs darkened at distal apices of femora and proximal base of tibia (‘knees’); tibial apices darkened near spurs; apices of successive tarsomeres brown with distalmost all dark. B.l. 6.2 mm, W.l. 2.4 mm. Head: Antenna flagellomere 137, 106, 100, 95, 165, AR 0.29; 14 clypeals, 3 clustered verticals. Palpomeres 50, 40, 205, 230, 240. Thorax. Ac ?9, Dc 11, Pa 3, Scts 15. Wing V.R. 1.14. Vein setation: R with 24, R<sub>1</sub> with 25 and R<sub>4+5</sub> 47–60, sq. 11. Leg lengths: P<sub>1</sub> 1100, 1120, 1500, 600, 500, 400, 200; P<sub>2</sub> 1200, 1160, 700, 400, 260, 200, 120; P<sub>3</sub> 1200, 1240, 900, 540, 380, 260, 140. Ratios: LR<sub>1</sub> 1.34, LR<sub>2</sub> 0.44, LR<sub>3</sub> 0.72; BV<sub>1</sub> 2.18, BV<sub>2</sub> 3.12, BV<sub>3</sub> 2.46; SV<sub>1</sub> 1.35, SV<sub>2</sub> 3.37, SV<sub>3</sub> 2.62. Foretibial spur short, nearly simple 30 long; midtibial 55, 55, rear 85, 75.

**Pupa.** Pale yellow with darker dorsal thorax, anterior wing sheaths and lateral apophyses on posterior abdominal segments; comb brown. Cephalic area without warts, dorsal thorax rugose with multiserial rows of tubercle. Hook row on II discontinuous, occupying c. 40% of tergite width. Conjunctival spinule bands on III – IV separated from posterior tergal armament, 4–5 spinules wide, medially absent (‘divided’). Pedes spurii B absent, vortex well developed. Abdomen (Fig. 4B) with tergites I and II essentially bare with few very fine spinules only immediately anterior to and narrower than hookrow. THII–VI anteriorly with transverse band of spinules, broadest on II, diminishing in lateral extent to VI, always well separated from paired posterolateral spinule patches; TVII and VIII with

few finest spinules. Taeniate setae V–VIII 3, 4, 4, 5;  $L_{3-5}$  on VIII clustered with respect to  $L_{1-2}$ . Comb (Fig. 4F) with 1 strong, inner spine directed postero-medially and 3–4 subordinate spines. Anal lobe with 60–65 taeniae in tightly packed biserial row.

**Larva.** Head capsule yellow with golden brown mental and mandibular teeth (inner only slightly darker than apical) and occipital margin narrow and dark brown. Dorsal head with clypeus ovoid-rhomboid, rounded posteriorly, clypeal setae inserted near to lateral margins (Fig. 6J). Antennal pedestal short. Antenna ( $n=1$ , not readily interpretable) with AR less than 1.0, segments 2–4 apparently subequal. Ventromental plate 15% longer than width of mentum. mandible with almost smooth mola, with only 1 very fine spine. Mensural features as in Table 2.

**Etymology.** From the type, and so-far only known locality, Paluma, a high elevation well-studied location in the southernmost wet tropics of north Queensland. To be treated as a noun in apposition.

**Diagnosis.** Although the male is unknown, matching to the female should show a broadly infusate wing, with darker band across the wing at the cross veins, and with legs darkened at the ‘knees’—the distal apex of femur and proximal apex of the tibia. Although the female holotype is quite teneral, the colour pattern will be stronger in fully hardened adults.

The pupa has a unique combination of features, although each state is shared with one or more other species yet never in combination. The hookrow on TII is medially divided (otherwise seen only in *R. hamodivisa*), and the conjunctival bands, present on tergites II and IV, also are medially divided (otherwise only in *R. kakadu*). The essentially bare TII is unique in the genus.

The larval head is uniformly pale, with mandibular and mental teeth golden brown. The antenna (only 1 of which is present, poorly laid out) can be determined to have a weak pedestal, a very low AR of 0.9, and ventromental plates 15% longer than the width of the mentum. The large clypeus (Fig. 6J), curved posteriorly with widely separated clypeal setae, is distinctive.

**Remarks.** Allocation of this taxon proved problematic, partially because of the lack of a male, but also because larval, pupal and female morphology do not converge on a single otherwise known species. The location, Birthday Creek near Paluma in north Queensland, is well studied, and has three other *Riethia* species (*R. cinctipes*, *R. queenslandensis* and *R. stictoptera*). This species cannot be allocated in any stage to these (or indeed any other) species of *Riethia*.

**Distribution and Ecology.** *Riethia paluma* is known only from a single reared specimen from well-sampled creeks in the mountains of the southern wet tropics immediately north of Townsville

### *Riethia phengari* Cranston sp.n.

(Figs. 1C, 2H, 4J, 6K)

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*Riethia* “moonlight” Cranston, 1966, 2000

**Type material.** **Holotype** Le/P♂, Australian Capital Territory (ACT), Moonlight Hollow, 35°25'S 148°47.30'E, 20.x.1991 (Cranston) (ANIC). Paratypes (all collected Cranston, deposited ANIC): Le/Pe, as holotype; 2L, Brindabellas, Blundell's Ck., 35°22'S 148°50'E, 24–27.viii.1988; ♂, Blundell's Ck., no further data (Colless); Pe, Condor Ck., 35°22'S 148°51'E, 27.x.1991.

**Other material.** Unreared larva, excluded from paratype series. Tasmania, South George R., intake bridge, undated, 41°18.39'S 147°56.02'E (MV, failed, TAS3).

**Description. Male.** Thorax yellow-brown without distinct vittae; legs yellow-with slightly darker tarsomeres, without banding. Wing pale, unmarked, with yellow veins. TIX with fine setae dense across complete tergite. Gonostylus broad at junction with gonocoxite, abruptly attenuated, bearing dense brush of broad, apically plumose setae on inner margin (Fig. 1C). Superior volsella with basal area bearing proximally 4 long setae, remainder bare except for posterior setose projection; medially-directed digitus virtually devoid of microtrichia, with 3 long setae; inferior volsella very small, almost totally appressed to inner contour of gonocoxite and linked to posterior part of superior volsella, with long simple setae; junction between superior volsella and inferior volsella bears 1 pectinate scale (Fig. 2H). No pseudovolsella, inner gonocoxal setae aligned, arising from weak tubercles, more dorsal than internal on gonocoxite. Mensural features as in Table 1.

**Female** unknown.

**Pupa.** Very pale, almost translucent, with pale yellow dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb pale yellow. Cephalothorax with almost smooth frons, thorax weakly rugulose with bi-triserial row of small tubercles along dorsal thorax each side of eclosion line. Hook row continuous on II, 45–50 % width of tergite; conjunctival spinule band on III and IV continuous. Pedes spurii B absent, vortex weak. Abdomen with tergite II with armament full width of hookrow posteriorly, tapering anteriorly and then expanded to form quite strong anterior transverse band of stronger spines; TIII–V similar to *R. azeylelandica* (Fig. 3D). TVIII and anal lobe bare. Taeniate setae V–VIII 3, 4, 4, 5, on VIII evenly distributed along segment. Comb with 1 strong postero-laterally directed tooth (Fig. 4J), with or without 1–2 very small lateral teeth. Anal lobe with c 55–60 bi-disorganised multiserial taeniae.

**Larva.** Head capsule golden, slightly browner on postmentum, occipital margin broad, dark brown, mentum and four inner mandibular teeth similarly golden-brown. Clypeus (Fig. 6K) trapezoid, stippled at least in posterior half. Inner margin of mandible with 2–3 strong serrations on mola commencing close to insertion of seta subdentalis. Each antennal segment shorter than preceding. The ventromental plates are 10–20% wider than the mentum. Mensural features as in Table 2.

**Etymology.** From φεγγάρι (phengári) Greek for moonlight, after the type locality of Moonlight Hollow.

**Diagnosis.** In the male the attenuated gonostylus (Fig. 1C) is unique. The pupa of *R. phengari* is near identical to that of *R. azeylelandica* (Fig. 3I) perhaps more nearly transparent without darkening and with fewer teeth in the ‘comb’ (Fig 4J v. 4I). The larva of *R. phengari* has a pale mentum and inner mandibular teeth scarcely darker than the uniformly pale-golden head. The antennal pedestal is very short and the AR is between 1.6 and 1.8 with the 3<sup>rd</sup> segment shorter than 2<sup>nd</sup>. The clypeus (Fig. 6K) resembles that of *R. azeylelandica* (Fig. 6D) but may be more rectangular and can have stippling in the posterior half.

**Remarks.** Based on the immature stages alone, *R. phengari* would be poorly differentiated from *R. azeylelandica*. The attenuated gonostylus of the reared holotype is seen also in a prior-collected male from close-by, housed in the ANIC. The genitalia are totally symmetrical so evidently this gonostylus is not teratological but represents a distinctive new species. The species is unrepresented by molecular material.

**Distribution and Ecology.** *Riethia phengari* is limited to a very small area of eastern Australia coincident with the mountains of the Australian Capital Territory. The streams are 2nd or 3rd order, in a region very widely surveyed including by drift netting over extended periods.

### *Riethia plumosa* Freeman

(Figs. 1D, 2I, 4C, 4G, 6L)

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*Riethia plumosa* Freeman 1961.

*Riethia plumosa*, larva, Cranston 1966, 2000

**Type material.** **Holotype**, ♂, pinned, abdomen on celluloid mount, AUSTRALIA: Tasm[ania]. Harz Mont, 10 Dec. 1922, *A. Tonnoir* [ANIC]. *Riethia plumosa* Freeman det. Freeman 1960 (2 labels). **Paratype** ♂, pinned, separate hypopygium on celluloid mount, Tasm[ania], National Park [Mount Field National Park], 17 Dec. 1922, *A. Tonnoir* [ANIC].

**Other material.** Collected Cranston, deposited ANIC, unless otherwise stated: New South Wales, Pe, Micalong Ck., 35°17'S 149°31'E, #2082; 2Pe, Monga SF, Mongarlowe R., 35°23'S 149°55'E, 2.iii.1991, #2080; Pe, Kosciusko N.P., Cave Ck., 35°37'S 148°39'E, 13–14.xi.1993, #2083; ♂, ♀, Spencers Ck., 36°26'S 148°20'E, 1773 m. a.s.l., 3.xii.2010; 5Pe, Murrumbidgee R., 35°38'S 148°34'E, 13–14.xi.1993, #2084; Pe, Brown Mountain, Rutherford Ck., 36°36'S 149°47'E, 16.x.1990 (*Cranston & Edward*), #2081.

Australian Capital Territory: 3♂, Brindabellas, Blundells Ck., 35°22'S 148°50'E, 13–16.iv.1988, #2079.

Victoria, P♂, Tambo R., Teapot Creek Track, 36°57'S 147°56'E, 27.iii.1991 (*Hortle*), #2085.

Tasmania, 2Pe, n.e. Tasmania, nr Weldborough, R. Wild, 23–24.v.1993, #2089; 9Pe, Cradle Mt.-L. St. Clair N.P., Dove L., 960 m a.s.l., 41°39'37"S 145°57'27"E, 25.i.2006; same except Le/P♂, 15–30m [depth]; Le/Pe/♂, L. St Clair, ‘from branch @ 12 m.’ [depth], 6.x.1972 (*Martin & Timms*); Pe, Frog Flat, 41°50'S 146°00'E, 25.i.1990, #2086; Pe, Backhouse Tarn, 1140 m a.s.l., 42°40'S 146°34'E, 7.ii.1992, #2090; Pe, P♂, 2♂ Mount Field N.P., L.

Fenton, 1006 m a.s.l., 42°40.5'S 146°37.5'E, 6.ii.1992; 2Pe, L. Dobson, 1040 m a.s.l. 42°41'S 146°35'E, #2094; 'tarn 1', 42°42'S 146°48'E, 1.iii.1997 (Wright) #2312.

**Description. Male.** Thorax brown, without distinct vittae; legs yellow-brown to darker brown on tarsomeres, without banding. Wing membrane pale, unmarked, with yellow veins. TIX densely setose with thin setae in undivided median cluster. Genitalia (Fig. 1D) with gonostylus broad at junction with gonocoxite, bearing many apically plumose setae on inner margin. Superior volsella (Fig. 2I) with proximal basal area bearing 4–5 long setae, remainder bare except for modest posterior setose projection; medially-directed digitus tapering to point, bare of microtrichia, with 4–5 long setae; inferior volsella very small, basally appressed to inner contour of gonocoxite with short free portion linked to distal part of superior volsella, with long simple setae, without pectinate scales. No pseudovolsella. Mensural features as in Table 1.

**Female.** Not known with certainty.

**Pupa.** Pale yellow, with slightly darker dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb yellow. Cephalothorax with almost smooth frons, weakly rugulose thorax, with bi-triserial row of tubercles running most of length of dorsal thorax beside eclosion line. Undivided hook row on II 40–45% width of tergite; continuous conjunctival spinule band on III and IV. Pedes spurii B absent, vortex strong. Abdomen (Fig. 4C) with tergite II with triangular armament, widest posteriorly, extending to width of hookrow, tergites III–V with broad anterior spinule patch with spinules scarcely stringer than more posterior, with which they are contiguous, TVI with oval anteromedian patch separated from postero-median triangular patch. Taeniate lateral setae 3, 4, 4, 5, evenly distributed on TVIII. Comb (Fig. 4G) with 3 postero-laterally angled teeth. Anal lobe with 55–65 multiserial taeniae.

**Larva.** Head capsule pale yellow to golden, trace of brown on postmentum, occipital margin dark brown, mentum and inner mandibular teeth golden. Clypeus (Fig. 6L) large, trapezoidal, broadened anteriorly with clypeal setae located antero-laterally. Antenna arising from distinct pedestal, antennal ratio 1.7–1.8, with consecutive segments shorter than preceding. Inner margin of mola with one strong spine retracted from seta subdentalis position. The ventromental plate is subequal to slightly longer than the width of the mentum. Mensural features as in Table 2.

**Diagnosis.** The male of *R. plumosa* has unbanded (plain) legs, conventional shaped gonostylus with a dense cluster of plumose setae on the inner surface. The pupa is conventional with continuous hook row on TII, conjunctive V without setae, cephalic area without warts, and tergite II with only few spinules, pedes spurii B absent and TII with posterior spinule patch as wide as hook row. The larva of *R. plumosa* rather closely resembles that of *R. phengari* in the pale colour of the head capsule and extent of pigmentation of the post-occipital margin. Although *R. plumosa* may differ in the paler mental and inner mandibular teeth, intensity of pigmentation may vary. The clypeus of *R. plumosa* is diagnostically large c. 70µ wide anteriorly, and 50µ deep. The structure of the inner margin of the mandible with a single somewhat basal slender spine in *plumosa*, contrasts with the several broad spines on the mola of others.

**Remarks.** The only rearings of this species are both from north-western Tasmania, which provide the basis for the description of the immature stages. Pupal exuviae provide evidence for presence also in upland south-eastern Australia, but the apparently distinctive larvae have not been recognised elsewhere, including amongst material collected for molecular study.

**Distribution and Ecology.** *Riethia plumosa* may be the most temperate species in the genus in Australia where the species is restricted to south-eastern Australia. The most northerly record (from 35°S) is at an elevation > 900 m a.s.l. as are most records from New South Wales. Many records are from Tasmania, from where the species was described, also at elevations of c. 1000 m a.s.l.. All locations are from healthy waters, notably including from upland standing waters in national parks in Tasmania.

### ***Riethia queenslandensis* sp.n.**

(Figs. 2J, 4M, 4N, 6M)

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*Riethia zeylandica* (part, Cranston 1966, 2000)

**Type material. Holotype.** Pe/♂, AUSTRALIA, Queensland, Oliver Ck., 16°08.37'S 145°26.21'E, 22–23.iv.1999



(*Cranston*) (ANIC). Paratypes (collected Cranston, deposited ANIC, unless otherwise stated): Queensland: Pe, P♀, Cape Tribulation, Mason Ck., 16°05.08'S 145°27.36'E, 23.iv.1999; 6Pe, Oliver Ck., 16°08.3'S 145°26.7'E (*McKie*), #2301; Le/P, 2Pe, Pe/♂, as holotype; Pe, as holotype except 10.ix.1997 (*McKie*); 5Pe, Rex Ck., 16°28'S 145°19'E, #2283; 8Pe, 5–6.iv.1997; #2281,6; 2Pe, 10–11.vi.1997, #2282; 2L, 5Pe, 17–18.xii.1997, #2283; 2L, 16Pe, 17–18.xii.1997, #2282,-4,-5; 2L, 7Pe, Le/P, Le/Pe/♀, P♂, 19–20.x.1998 (*Cranston & Dimitriadis*) #2208; P♀, Mt. Lewis, Windmill Ck., 16°34'S 145°16'E, 4.ix.2005; 6Pe, trib. Churchill Ck., 16°34'S 145°20'E, 6–7.iv.1997; Pe, Shoteil Ck., 16°56'S 145°37'E, 9–10.ix.1997, #2302; 8Pe, nr. Mareeba, Davies Ck., 17°01'S 145°35'E, 17–18.xii.1997; Pe [same slide as paratype *R. azeylelandica*] Mt. Haig, Emerald Ck., 17°06'24"S 145°36'52"E, 17–18.xii.1997; 3Pe, Herberton, Carrington Falls Ck., 800 m a.s.l., 17°20'S 145°27'E, 9–10.iv.1997 #2289; L, 3Pe, Nigger Ck., 17°26.48'S 145°29'E, 9–10.iv.1997, #2291; same except 6L(P), 19–20.xii.1997, #2290; 4Pe, Palmerston N.P., Tchooratippa Ck., 17°37'S 145°45'E, 8–9.iv.1997, #2293; Pe, Python Ck., 17°46'S 145°35'E (*McKie*), #2303; 2Pe, 2P♂, Pixies Ck., 17°47'S 145°41'E, 2–3.ix.1997 (*McKie*) #2304-6; 10Pe, 2P♂, P♀, Cardwell, 5-mile Ck., 18°20'S 146°03'E, #2304-6; Pe, Yuccabine Ck., 9.vi.1997 (*McKie*); 4Pe, Paluma, Birthday Ck., 18°59'S 146°10'E, 25–26.iii.1998; Pe, Eungella N.P., Dalrymple Rock Rd., 950 m a.s.l., 21°02'S 148°34'E, 22.iii.1998; Pe, Cooloolool N.P., Frankis Gulch, 26°03'S 153°04'E, 6.iv.1996, #2300.

Excluded from paratype series: 2Pe, Queensland, Emmagen Ck., 16°02'S 145°27'E, 9–10.ix.1997 (*McKie*). Exuviae fit description but are darker especially the conjunctives and clearly lack vortex.

**Other material.** Queensland, L, Emerald Ck., 16°58.50'S 145°34.00'E, 8.ix.2007, 360 m a.s.l. (*Krosch*) (MV FNQDE2R); 4L, Paluma, Little Birthday Ck./ Camp Ck., 18°58'22"S 146°09'52"E, 850 m a.s.l., 21.ix.2008 (*Krosch*) (MV FNQCC1R1, FNQCC2R1, FNQCC3R2, FNQCC3R1(3i)); 5L, Birthday Ck., 18°58.35'S 146°09.26'E, 22.ix.2008, 800 m a.s.l. (*Krosch*) (MV FNQBC5R1, FNQBC6R1,2,3,4); L, Paluma site #1, Birthday Ck., 18°58'S 146°09'E (*Krosch*) (MV PAa42); 4L, Cooloolool N.P., Frankis Gulch, 26°02.50'S 153°04.44'E, 18.iv.2009 (*Krosch*) (MV AU09FGR2, 1,7,8).

**Description. Male** (all teneral/pharate). Thorax yellow, with slightly darker vittae; legs brown, without banding. Setae of TIX thin, long, clustered, denser medially. Gonostylus narrow at junction with gonocoxite, which bears only simple setae. Superior volsella (Fig. 2J), predominantly bare, except for 2 long setae disto-laterally, posterior setose projection continuous with inferior volsella, medially-directed, apically rounded digitus devoid of microtrichia, with 4–5 simple setae; inferior volsella well developed, basally appressed to inner contour of gonocoxite and linked to superior volsella, subapically with 6–7 pectinate scales and many long simple setae. Inner gonocoxite setae dispersed, linear, without tubercle (Fig. 2J). Mensural features not tabulated, teneral (n=2), B.l. c. 2.8 mm, W.l. c. 1.2–1.6 mm, AR 1.1–1.3, temp 18, clyp. 16, palp (1–4) 40–50, 115–125, 140–150, 180–190; ac 10–11, dc 8–10, Pa 3, Scts 12–17; LR1 0.95–1.0, BV1 2.14, SV1 1.8.

**Female.** Pigmentation as in male, AR 0.35, LR not measureable.

**Pupa.** Pale to brownish, with yellow-brown dorsal thorax, slightly indicated lateral apophyses on abdominal segments V–VIII; comb yellow. Frons essentially smooth with well-developed smooth to slightly tuberculate warts, contiguous from base to rounded apex. Cephalothorax with several rows of dorsal tubercles. Abdomen with continuous narrow hook row on II, c. 30–35% of segment width, and continuous conjunctival spinule bands on III and IV. Pedes spurii B distinct; vortex weak or absent. Tergites essentially as in *azeylelandica* (q.v.) with rectangular dense armament, anterior transverse band nearly as broad as posterior armament on TII–VI; TVII with medio-posterior triangular area of spinules, TVIII posteriorly with microspinulation (Fig. 4M), with few microspinules on anal lobe. Taeniate setae V–VIII 3, 4, 4, 5 on VIII evenly distributed along segment. Anterior sternites bare, with spinules on posterior of sternite VI and VII, sometimes on VIII (Fig. 4N). Comb with 1 stronger posteriorly-directed spine and 2–3 weaker outer subsidiary spines, also directed posteriorly. Anal lobe with 45–55 taeniae inserted biserially.

**Larva.** Head capsule golden-brown with posterior postmentum and genae variably dark, with occipital margin only slightly darker, mandible golden yellow, mentum and inner 3 mandibular teeth brown. Clypeus (Fig. 6M) flared anteriorly. Inner margin of mandible with serrations starting close to insertion of seta subdentalis. Premandible with small but distinct 5th (proximal) tooth. Antenna arising from distinct pedestal; AR 1.8–2.0, with 2<sup>nd</sup> segment distinctly longer than 3<sup>rd</sup> which is subequal to the 4<sup>th</sup>. The ventromental plate is subequal to slightly shorter than the mentum width. Mensural features as in Table 2.

**Etymology.** The species epithet reflects the restriction of this species to the state of Queensland.

**Diagnosis and remarks.** Adult males of *R. queenslandensis* conform to a 'zeylandica' group, as does the sometimes sympatric *R. azeylelandica*. These two eastern Australian species may differ from one other only in subtle

differences in the shape of the inferior volsella. In *R. queenslandensis* the inferior volsella appears to have a ridge bearing the pectinate setae subapically, on the same plane as the superior volsella (Fig. 2J). In *R. azeylelandica* the curved and broader inferior volsella has no such ridge and originates more ventral than the superior volsella (Fig. 2A).

The pupa of *R. queenslandensis* superficially resembles others but has weakly indicated apophyses and tuberculose, rounded cephalic warts compared to the wart-less *R. azeylelandica* (with which it can be sympatric) and *R. phengari*. In *R. queenslandensis* the spinulation on the posterior tergites is unusual. The spinulose SVI and SVII (female) and posterior third of VIII (male) in *R. queenslandensis* (Figs. 4M, N) enhance species distinction as all sternites are bare in *R. azeylelandica* and *R. noongar*.

The larvae of *R. queenslandensis* resemble *R. azeylelandica* also in having a high AR of 1.8–2.2, but the 3<sup>rd</sup> and 4<sup>th</sup> are subequal in *R. queenslandensis* (4<sup>th</sup> shorter than 3<sup>rd</sup> in *R. azeylelandica*). The pigmented posterior head of *R. queenslandensis* may be more restricted to the prementum and less dark than in *R. azeylelandicus*. The clypeus is more variable than figured but consistently has stronger anterolateral projections than *azeylelandicus* (Figs. 6L versus 6D).

Although *R. queenslandensis* resembles *R. azeylelandica* in morphology, molecular data show segregation of the two species is supported and the clusters show the morphological distinctions described above.

**Distribution and ecology.** *R. queenslandensis*, as the name implies, is restricted to the state of Queensland, between 16° and 26°S. Sampling shows high abundance in rainforest streams from subcoastal to submontane, all in good ecological condition. Distinguished from the more widespread eastern Australian *R. azeylelandica* by molecular and pupal morphological data allows recognition of abundance in low order but likely permanent creeks. Based on pupal exuviae, the two species co-occur in Upper Emerald Creek (17°06'24"S 145°36'52"E), mounted on same slide as, and curated under *R. azeylelandica*.

### ***Riethia stictoptera* Kieffer**

(Figs. 1E, 2K, 4D, 4H, 5B, C, I, 6N)

*Riethia stictoptera* Kieffer 1917: 203

*Riethia astictica* Kieffer 1917: 205. Synonymy by Freeman 1961: 678.

[All types of both species, MNH (Musei Nationalis Hungarici, Budapest, Hungary) believed lost by Freeman 1961; not found since].

**Material examined** (collected Cranston, deposited ANIC, unless otherwise stated): AUSTRALIA: Queensland ♂, McIlwraith Range, 15 km WNW Bald Hill, [estimated 13°44'S 143°20'E], 27.vi.–12.vii.1989 (*Naumann*) #2103; 1♂, 8Pe, nr. Mareeba, Davies Ck., 17°01'S 145°35'E, 17–18.xii.1997, #2104–5, 3Pe, 19–20.vi.1997; 3Pe, 27–28.viii.1997, 8Pe, 17–18.xii.1997; 4Pe, Palmerston N.P., Learmouth Ck., 17°35'S 145°42'E, 8–9.iv.1997, #2107; Le/P, nr Cardwell, 5 Mile Ck., 18°19.41'S 146°02.55'E, 17.xii.1997, #2110; ♂, Lawn Hill N.P., Musselbrook, Amphitheatre, 18°21'S 133°51'E, 13.v.1995, #2108; Le/Pe/♀, Paluma, Birthday Ck., 1.x.1998 (*McKie*); Pe, unnamed ck. s. of Paluma, 19°01'S 146°13'E, 25–26.iii.1998; Pe, Eungella N.P., Dalrymple Rock Rd., 950 m a.s.l., 21°02'S 148°34'E, 22.iii.1998.

New South Wales: Pe, Chaelundi S.F., Chandlers Ck., 30°02.22'S 152°29.26'E, 11.iv.1996, #2132; Pe, Barrington Tops, Dilgry R., 31°54'S 151°34'E, 14.iv.1990, #2119; ♂ (mounted from pinned by Cranston), Hornsby, 9.x.1958, at light (*D.J. Lee*) det. P. Freeman 1958; Pe, Farnworth Ave., Megarritys Ck., 33°53.10'S 150°36.30'E, 7.v.1993 (*AWT*), #2154; Pe, Scotchey's Ck., Lachlan Ck., 33°54'S 151°27'E, 7.v.1993 (*AWT*), #2154; Pe, Belmore Falls, Barrengarry R., 34°38'S 150°33'E, 16.xii.1992, #2122; 3Pe, 3.iv.1991; Pe, Taralgo Ck., 34°22'S 149°54'E, 8.x.1991 (*Drayson*) #2136; ♂, 12 m. west of Euston, 34°45'S 142°45'E, AN#28, 18.xii.1967 (*Nankivell & Gas-sner*); Pe, nr. Tarago, L. Bathurst, e. shore (the Morass), 35°03'S 149°44'E, 16.x.1993, #2130; 3Pe, Endrick R., 6 km. E. of Nerriga, 35°05'S 150°08'E, 1.ix.1988, #2116; Shoalhaven R., 2Pe, Hillview, 35°11'S 149°57'E, 17.iii.1992, #2127; ♂, Windellama, 35°21'S 149°44'E, 17.ii.2019; Le/Pe/♀, Warri Bridge, 35°21'S 149°44'E, 28.i.1992; 4Pe, 31.iii.1991, #2123; Pe, 17.iii.1992, #2125; 3Pe, Monga S.F. [N.P.], Mongarlowe R., 35°23'S 149°55'E, 2.ii.1991, #2120; Pe, Ballalaba Bridge, 35°34'S 149°47'E, 2.ii.1991, #2124; Le/Pe, Currowan S.F., Cabbage Tree Ck., 35°34'S 150°02'E, 30.iii.1994, #2128,9; 5Pe, 21.i.1999 (MVAUS09 CTC#); Pe, Kosciuszko N.P., Yarrangobilly R., 35°44'S 148°29'E, 15.i.1991, #2133; Pe, S.W. Araluen, Deua R., 35°45'S 149°57'E, 9.xii.1990, #2118; Pe, same except

29.iii.1988, #2117; 6Pe, Kosciuszko N.P., 3 Mile Dam, 25.xii.1991; #2134; ♂, 6 m. north of Narellan, 35°59'S 145°55'E, AN#28.1, 13.xii.1963 (*Martin*); Albury, Murray River, Pe, Union Bridge, 36°05'S 146°58'E, #2150, P♂, 30.i.1991 (*Cook*); 8Pe, 'Station 6', 36°06'S 147°01'E, 26.vii.1989 (*Taylor/Cook*) #2151–2; Pe, Noreuil Park, 36°05'S 146°56'E (*Cook*), #2138, Le/Pe/♀, 24.i.1990, #2139; c. 50Pe, Waterworks, 36°07'S 146°54'E, vi.–1990–iv.1991 (*Cook*) #2140–49; Le/Pe/♂, 'Corp' reared' (? *Cook*); Mt. Imlay, Wallagaraugh R., 37°15'S 149°41'E, 13.i.1994, #2135.

ACT /NSW: Jervis Bay, L. McKenzie, 35°09'S 140°41'E, 19.xii.1997, #2115; 13Pe, 7.ix.1996 (*Wright*); Pe, 28.iv.1997; Pe, 12.ix.1997; 1 Pe, 4.i.1998; Pe, 7.ii.1998.

ACT: ♂ (slide from pinned by Cranston), Gungahlin, 17.i.1959 (*A.L.Dyce*), det. Freeman 1960; L. Burley Griffin, Lotus Bay, 35°17'S 149°08'E, 29.xii.1991 (*Rosewarne*); #2114; 2Pe, below Cotter dam, 35°21'S 149°56'E, 7.xi.1987; #2111; Pe, Namadgi N.P., Orroral R., 35°39'S 149°59'E.

Victoria: Wodonga, Middle Ck., Pe, Down St., 36°10'S 146°52'E 22.i.1990 (*Cook*) #2160; 3Pe, Beechworth Rd, 36°15'S 146°50'E (*Cook*) #2159; Pe, Boyes Rd., 7.xii.1989 (*Cook*); Le/Pe/♀, Melbourne, Botanic Gardens, 37°50'S 145°00'E, 4.viii.1971 (*Martin*); Le/Pe/♂, Belgrave Reservoir, 37°55'S 145°21'E, 23.vii.1969 (*Martin*); Le/Pe/♂, Lilydale, 37°55'S 150°10'E, L. coll. 11.vii.1962, em. 7.xi.1962 (*Martin*); Le/Pe/♀, same except L. coll. 16.vii.1962, em. 25.x.1962; ♀, Werribee R., 37°55'S 145°40'E, 21.xi.1985, L. coll. 21.xi.1995, em. 27.x.1962 (*Martin*); 1♂, Yarra River, 2km S. Wonga Park (*Neboiss*), 23.ii.1976; Pe, Swan L., 38°12'S 141°19'E, 20.xii.1996 (*Wright*).

Tasmania: ♂, Flinders Island, Lady Barron, Scott's Lagoon, AF1#3.2, 40°10'S 148°22'E, 11.ii.1976 (*Martin & Lee*); Le/Pe/♂, Table Cape, 7km n.w. Wynyard, 40°56'S 145°41'E (*Martin*) #2171; 2Pe, Waterhouse CA, Little Waterhouse L., 40°52'S 147°36.5'E, 22.iii.1997 (*Wright, Swanson*) #2309; 10Pe, nr Weldborough, Nothofagus Forest, 41°10'S 147°54'E, 20–25.iii.1993 (*Trueman et al.*) #2181–2; Cradle Mt.–L. St Clair N.P., Pe, L. Ayr, 41°49'S 146°03'E, 25.i.1990, #2169; ♂, Cradle Mt. N. P., 41°41'S 145°50'E, AT#27.4, 18.x.1972 (*Martin*); Pe, West Coast Ranges, L. Selina, 41°53'S 145°36'E, 27.iii.1997 (*Wright, Swanson*) #2310; Pe, Central Plateau, nr. L. Ada, 1160 m a.s.l., 41°53'S 146°25'E, 15.iii.1997 (*Wright*); ♂, L. Leake, 42°00'S 147°48'E, AT#29.1, 21.x.1972 (*Martin*); Le/P., L. St Clair (*Martin, Timms*) #2169; Pe, L. St Clair, 42°06'S 146°11'E, 19.i.1990, #2173; ♂, Le/Pe/♂, Penstock Lagoon, 13 miles S. Miena, 42°05'S 146°46'E, 1.x.1971 (*Martin*); 2Pe, Forgotten L., 980 m a.s.l., 42°06'S 146°07'E, 25.iii.1997 (*Wright*) #2311; ♂ (pharate), Tooms L., 28 km. south-east of Ross, 42°19'S 148°10'E, AT#18.1, 12.x.1972 (*Martin & Timms*); Pe, Mt. Field N.P., Backhouse Tarn, 1140 m a.s.l., 42°40'S 146°34'E, 7.ii.1992, #2174; Pe, L. Seal, 900 m a.s.l., 42°40'S 146°35'E, #2180; 3Pe, 1♂, L. Fenton, 1006 m a.s.l., 42°40'S 146°37'E, #2178, 9; 2Pe, L. Dobson, 1040 m a.s.l., 42°41'S 146°35'E, #2177; L, 2Pe, Fairy Tarn, 940 m a.s.l., 42°42'S 146°35'E, 7.ii.1992, #2175–6; Pe, Beatties Tarn, 970 m a.s.l., 42°42'S 146°48'E (*Wright*) #2313.

South Australia: 5Pe, Ewens Ponds, 38°01'S 140°49.5'E, 19.xii.1996 (*Wright*) #2307; 4Pe, Mount Gambier, L. Edward, 37°37.6'S 140°36.2'E, 22.xii.1996 (*Wright*), #2308; Pe/♂, 7 m. depth, 19.viii.1975 (*Martin, Canning*); #2167.

Western Australia: 3♂, Kimberley, Synnot Ck., CALM site 25/1, 16°31'S 125°16'E, 17–20.vi.1988 (*Weir*) #2102.

Northern Territory: 5♂, 1♀, Kakadu N.P., Radon Spring, 12°45'S 132°55'E, 13–14.iv.1989, #2095; ♂, Boroalba Creek Springs, 19 km. NE by E. Mt Cahill, 22.dec.1972, *D.H. Colless*, at light; ♂, Graveside Ck., 13°18'S 132°32'E, viii.1989 (*Dostine*) #2098; Pe, Arnhem Land, nr. Narbaluk, Cooper Ck., 12°18'S 133°20'E, 27.v.1988, #2099; Pe, W. MacDonnell Range, inner Serpentine Gorge, 23°35'S 132°31'E, 8.iii.1995, #2101; 2Pe, Serpentine Gorge, 23°41'S 133°43'E, 27.v.1992, #2100.

**Other material.** Le/Pe/♂, Victoria, Emu Bottom (*Martin*) AV.141 (ZSM), det. *Riethia stictoptera* by Martin, confirmed M. Spies (*pers. comm.* 2019).

**Description. Male.** Thorax brown, with distinctive darker vittae. Legs pale with brown bands across femoral-tibial junctions, at apices of tibia and tarsomeres 1–3, and all of tarsomeres 4–5; abdomen with brown transverse bands on segments 2–4 or 5. Wing membrane darkened over forks of R and FCu. TIX setae fine, long medially, shorter laterally, arranged into two closely approximated clusters. Genitalia (Fig. 1E) with uniquely shaped gonostylus, triangular, tapering medially to narrow and slightly hooked point, bearing only simple setae. Superior volsella (Fig. 2K) large medially directed lobe, with microtrichia and macrotrichia, without posterior projection. Inferior volsella separate from superior volsella, fused to inner margin of gonocoxite excepting short free section, with long simple setae, without pectinate scales. Pseudovolsella absent. Mensural features as in Table 1.

**Female.** Pigmentation as in male, AR 0.35, LR<sub>1</sub> 1.0–1.05.

**Pupa.** Brown with darker dorsal thorax, anterior wing sheaths and lateral apophyses on all abdominal segments;



comb brown. Cephalothorax with crenulate frons without warts, thorax rugose with multiserial tubercle rows on anterior dorsum. Hook row on II continuous, occupying c 45–50% tergite width, with continuous conjunctival spinule bands on III–IV. Pedes spurii B well developed on II, vortex large. Abdomen (Fig. 4D): tergite II with small triangular area of armament narrower than and just anterior to hookrow, without anterior spines, TIII–V with armament more or less rectangular, quite dense, with anterior transverse band at least as broad and of larger spinules than of posterior armament, TIII–V with strong anterior spinules and attenuated triangular medioposterior area; TVI with anterior ovoid area slightly separated from posterior area, TVII and VIII with modest microspinulation anteriorly. Taeniate setae V–VIII 3, 4, 4, 5, on VIII with  $L_{3-5}$  clustered with respect to  $L_{1-2}$ . Comb (Fig. 4H) with 1 stronger, triangular spine directed postero-medially, 2–3 weaker inner spines. Anal lobe with 55–65 taeniae in disorganised biserial row.

**Larva.** Head capsule yellow with dark postmentum and broad almost black occipital margin; mentum (Fig. 5B) and 4 inner mandibular teeth (Fig. 5C) golden-brown. Clypeus (Fig. 6N) oval, wider anteriorly with somewhat flared anterolateral lobes; clypeal setae placed near to lateral margin. Inner margin of mandible with one broad lobe near insertion of seta subdentalis and 3 spines near mid-point of mola. Antenna (Fig. 5I) with AR 1.2–1.4; 3<sup>rd</sup> segment much longer than 2<sup>nd</sup>, with conventional wall (not thinned as in other taxa with long 3<sup>rd</sup> segment). Ventromental plates 6–17% wider than mentum width. Mensural features as in Table 2.

**Diagnosis.** The combination of banded legs and unique gonostylus morphology is diagnostic. The short gonostylus fused to, and uncertainly separated from the gonocoxite, tapers abruptly to a postero-medially directed point, and bears only simple setae.

The pupa of *R. stictoptera* is much less distinctive. It has a continuous hook row and conjunctives with continuous spinule rows restricted to III, IV with V bare. Tergite II is almost free of spinules, with, at most, postero-medially of small spinule area, narrower than the hook row. Differentiation from a rather similar pupa of *R. plumosa* can be made on the larger spinule area on tergite II of *R. plumosa* and lack of a pedes spurii B.

The larva of *Riethia stictoptera* has a characteristically darkened prementum but pale genae, an antennal ratio of c. 1.4 and the clypeus variably broadened anteriorly (Fig. 5M).

**Remarks.** The gonostylus shape of this species is unique and although the gonostylus illustrated by Kieffer (1917: Fig. 6b) is folded back on top of the gonocoxite, the diagnostic shape can be inferred.

A recent paper concerning *Manoa* by Qi *et al.* (2017) recognises two different barcode DNA sequences for *R. stictoptera* suggesting a misidentification in database(s). The author of sequence CAUS02310, identifies the vouchered larva as a species of *Kiefferulus*, and not *Riethia* (Dr Jon Martin, Melbourne, *pers. comm.*). As stated under *R. azeylelandica* above, the larval voucher MV903 (Cranston *et al.* 2010) identified as *R. stictoptera* is corrected here to *R. azeylelandica* (q.v.).

**Distribution and ecology.** *Riethia stictoptera* is the most widespread and pollution tolerant of species of *Riethia*. Although the only Western Australian record is from the Kimberley (the n.w. of the state), the species occurs widely across the border in Northern Territory including the ‘red centre’ and in the centre of Queensland’s Cape York Peninsula. In eastern Australia, *R. stictoptera* is found from 13°S to central Tasmania at 42°S and westwards in South Australian lakes. This species is found in a diversity of standing waters from ornamental pools, ponds, lowland billabongs to upland oligotrophic tarns. It is found also in large nutrient-enriched rivers such as the Murray River between Victoria and New South Wales.

### ***Riethia wazeylelandica* Cranston sp.n.**

(Figs 2L, 6O)

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**Type material.** **Holotype** P♂, AUSTRALIA, Western Australia, North Dandelup, Foster Brook, Foster Brook, [32°30’S, 116°02’E], 11.vii.1990 (*Edward*) (WAM). **Paratypes**, P♂, Le/P♀, Western Australia, North Dandelup R., 10.viii.1995 (*Armstrong*) (ANIC); L head + ♂ genitalia, Seldom Seen Brook, 32°15’S 116°04’E, 20.viii.1982 (*Edward*) (WAM).

**Description.** **Male** (n=1–2, teneral): Thorax brown, without distinct vittae; legs brown, without banding. Wing membrane unmarked. Setae of TIX fine, medium-lengthed, arranged in +/- horseshoe shape. Gonostylus narrow at junction with gonocoxite, which bears only simple setae. Superior volsella proximally with 4–5 long setae in mi-



crotrichiose region, posterior setose projection well developed (Fig. 2L) medially-directed apically rounded digitus devoid of microtrichia, with one pectinate scale, 3–4 simpler setae nearer apex. Pseudovolsella low bearing 2 moderate-lengthed strong etae. Inferior volsella appressed basally to inner contour of gonocoxite and linked to distal part of superior volsella, with 5–6 pectinate scales and many long simple setae. Mensural features cannot be tabulated on the teneral males.

**Female** teneral, apparently as in male.

**Pupa.** Pale with yellow dorsal thorax, anterior wing sheaths and lateral apophyses on abdominal segments V–VIII; comb yellow. Cephalothorax almost smooth, with minor tuberculosity only along ecdysial line. Abdomen with continuous hook row on tergite II c. 40% of tergite width; conjunctival spinule bands complete on III and IV, on V weaker but continuous. Pedes spurii B absent, vortex strong. Abdomen with tergite II–VI with armament +/- rectangular, sparse, with anterior transverse band distinctive by density of spines—no stronger on II than remainder of tergites; TVII and VIII and sternites bare but tergal and sternal patterns difficult to interpret on pharates. LS setae on V–VIII 3, 4, 4, 5 on VIII more or less evenly spaced. Comb with 1 strong triangular tooth, 2–3 weaker posteriorly-directed spines. Anal lobe with 45–55 taeniae in biserial to partly multiserial row.

**Larva.** Head capsule pale yellow with narrow brown occipital margin, mandible golden yellow, mentum and inner mandibular teeth brown (innermost 4<sup>th</sup> incompletely separated from mola). Clypeus (Fig. 6O) c. 2× as wide as long, indented laterally, with clypeal setae strongly retracted. Inner margin of mandible with broad spine beside insertion of seta subdentalis and 3 serrations further towards base of mola. Each antennal segment shorter than that preceding; blade not extending to antennal apex. Ventromental plate diagnostically short, only 75% of mentum width. Mensural features as in Table 1.

**Etymology.** The epithet derives from *zeylandica*, with which this species had been confused, combined with prefix ‘wa’ showing it is Western Australian.

**Diagnosis.** In the male genitalia of *R. wazeylandica*, uniquely in the genus, a solitary pectinate seta lies at the base of the digitus of the superior volsella. The cluster of 5–6 pectinate setae on the lobe of the superior volsella distinguishes from the otherwise similar and also Western Australian *R. noongar* that has only simple setae on the superior volsella.

The pupa of *R. wazeylandica* has the 3 posterior taeniate ( $LS_{2-4}$ ) setae on segment VIII clustered, in contrast to the more even spacing of these setae in *R. azeylelandica*.

The larva resembles *R. azeylelandica* in having contrasting darker mentum and mandible and antennal segment 3 shorter than the 2<sup>nd</sup>. With an AR of 1.4–1.6, narrow postoccipital margin and short ventromental plates, the larva closely resembles that of *R. noongar*, another Western Australian species.

**Remarks.** The dorsal head sclerites, notably the clypeus (Fig. 6F, 6I, 6O), varies enough to allow separation of unreared larvae of the 3 western Australian *Riethia* from each other and from other Australasian species. No genetic information is available for this taxon.

**Distribution and ecology.** *Riethia wazeylandica* is restricted to Western Australia in a limited area of karri and jarrah forested streams.

### ***Riethia zeylandica* Freeman 1959**

(Figs. 1F, 2M, 4O, 6P)

*Riethia zeylandica* Freeman, 1959: 422

[not *Riethia zeylandica* Freeman 1961: 680]

**Type material.** **Holotype** ♂, pinned, hypopygium on celluloid mount, NEW ZEALAND, Ohakune, .xi.1922 (*T.K. Harris*) BM 1923-13 (BMNH). Examined, hypopygium drawn, September 1998.

**Other material** (all *Cranston* ANIC / NZAC): NEW ZEALAND: N. Island, 24Pe, Pukete Forest, 1–2 order stream (unnamed), 35°12.52'S 173°47.43'E, 12.i.2000; Le/P♂, 35°12.41'S 173°47.37'E, 30.i.2006; 2L, P♂ same (MV NZ10PSR1-2, PSRP1) 27.xiii.2010.

**Description.** **Male**, n=1–3 [based on Freeman 1959, re-examination of holotype by Cranston; the only new specimens are teneral within pupa]. Body pale green with light brown thoracic bands; wing and legs pale, without markings. Antennal ratio 1.05 [Freeman states 1.3]. Legs with all tarsomeres missing, ratios unable to be calculated [Freeman ‘slightly more than 1’]. Hypopygium (Fig. 1F) [Freeman 1961: fig. 3a] with 4–6 clustered stout setae on

anal tergite near posterior margin and interspersed with regular setae. Gonocoxite slightly narrowed at junction to gonostylus, gonostylus tapering to point. Superior volsella (Fig. 2M) with basal 'heel' prior to non-microtrichiose elongate, non-tapered, bare lobe bearing 4–6 simple setae and without pectinate scales. Pseudovolsella an angular protrusion (not a tubercle) bearing 3 slightly approximated long setae. Inferior volsella well developed, microtrichiose, curved medially, subapically with 7–8 pectinate setae and several simple setae. Mensural details, see Table 1.

**Female** unknown.

**Pupa.** Almost hyaline except for yellowish dorsal thorax, anterior wing sheaths; tergal spinules golden, apophyses almost invisible except on VIII; comb yellow-brown. Frons with short warts, cephalothorax smooth, with one row of tubercles each side of dorsal ecdysial line. Prealar tubercle modestly developed as rectangular to elongate rounded lobe. Continuous hook row on II occupying 30–35% width of segment II; continuous conjunctival spinule band on III, IV and sparser on V. Pedes spurii B absent, vortex very weak. Tergite I bare, II–V with quadrate armament of quite dense spinules, without strongly delimited anterior or posterior transverse band; VI with more patchily distributed spinules although essentially quadrate; VII and VIII bare. Segment V with 3L setae, all non-taeniate, VI–VIII with 0, 4, 4, 5 taeniate LS, on VIII more or less evenly spaced (Fig. 4O). Sternites bare. Tergite VIII posteriorly with yellow apophyses meeting comb comprising few golden spines, the strongest directed posteriorly, and innermost directed more posteromedially. Anal lobe with 40–50 biserial taeniae.

**Larva.** The head is evenly pale pigmented with postoccipital margin broad and dark, and mentum and inner mandibular teeth distinctly brown. The clypeus (Fig. 6P) has an indented lateral margin with clypeal (S3) setae located midway between anterior and posterior margins. Antenna with short pedestal; AR c. 1.4, each segment shorter than preceding (thus 3<sup>rd</sup> shorter than 2<sup>nd</sup>). Premandible with very small basal-most tooth, essentially with 4 teeth. Mandible with gold apical tooth and 4 dark inner mandibular teeth, seta subdentalis arising from pointed lobe, with 1–2 molar spines. Mentum relatively narrow with ventromental plates of similar width. Mensural details, see Table 2.

**Diagnosis.** The adult male closely resembles the Australian *R. azeylelandica*, differing mainly in the pseudovolsella. In both species it bears 3 setae, but in *R. zeylandica* these arise from a distinct angular lobe (Fig. 2M), whereas there is no such lobe in *R. azeylelandica* (Fig. 2A), with setae arising from the inner contour of the gonocoxite.

The pupa, with continuous hook row and conjunctival spinule bands on II, IV and V, is unlike any taxon in the 'zeylandica' grouping from Australia. The conjunctive of V has a sparse, perhaps narrowly medially-divided band of spinules, well separated from posterior tergal spinules and weaker than in possibly conspecific Australian specimens, all of which have a denser band on V. The absence of taeniae on the lateral segment V is unique in the genus, and led to early inability to recognise the pupal exuviae as belonging to *Riethia* due to (0), 4, 4, 5 pattern of taeniate LS.

The larva with an AR of 1.4 with consecutively shorter segments and smooth clypeus probably is only confidently identifiable by its restriction to New Zealand, whereas look-alikes are Western Australian.

**Remarks.** The resemblance of the adult male of *R. zeylandica* to Australian specimens allocated by Freeman (1961) to this species is evident and misidentification is quite understandable. Although molecular data shows distinction, and the pupae provided strong morphological confirmation, particularly in the non-taeniate LS on segment V and weak to absent vortices on IV, differentiation of the male and larva from some Australian congeners remains uncertain.

Intensive searches around the type locality of Ohakune revealed no *Riethia* in any life stage. Since Harris's original collection in 1922, the local volcano Mount Ruapehu has erupted several times, and conceivably local stream conditions no longer suit *Riethia*. The species was found much further north in Pukete Forest (Northland, Kerikeri) from drifting pupal exuviae in 2000, with larvae and pharate adults found in 2006 and larval molecular material collected in 2010. The life history association derives from molecular data of 2 unreared larvae and a pharate pupa with clearly visible male genitalia within.

**Distribution and ecology.** Pukete Forest in northern New Zealand is a large intact tract of native forest dominated by ancient *Agathis* (Kauri) trees. The low order streams where *Riethia* occur are of modest gradient, with rocky substrate and filled with leaf litter. Apparently represented by the sole species, *Riethia* has been found nowhere else in the country despite widespread sampling across both North and South islands, including in other ancient forested streams (see above).

**TABLE 1.** Morphometric data for males of *Riethia* Kieffer

MALE	<i>azeylandica</i>	<i>cinctipes</i>	<i>donedwardi</i>	<i>homodivisa</i>	<i>kakadu</i>	<i>neocaledonica</i>	<i>noongar</i>	<i>phengari</i>	<i>plumosa</i>	<i>stictoptera</i>	<i>zeylandica</i>
n=	5-8	4	4	1-2	4	10	2	1	4	3	1
B.l. (mm)	3.6-5.6	5.0-6.0	2.5-6.4	3.6-4.2	2.7-3.4	4.3-5.0	4.8-5.1	4.2	5.6-6.0	4.5-5.0	3.9
W.l. (mm)	1.8-2.6	2.1-2.2	1.4-2.5	1.62.0	2.4-2.6	2.2-2.5	2.5	2.9	2.8-3.0	2.1-3.0	2.9
Fl.13	460-900	760-860	720-900	360-605	495-550	580-625	720-755	875	850-900	750-970	600
Fl.1-12	410-460	450-550	390-400	360-440	325-360	400-450	380-425	515	410-490	380-440	570
AR	1.1-1.6 [2.0]	1.55-1.80	1.84-2.25	1.0-1.4	1.4-1.6	1.4-1.5	1.8-1.9	1.7	1.7-1.8	1.8-2.0	1.05
temp	11-21	8-10	12-23	16	8-12	18-26	21-22	16-18	22-28	19	15-17
clyp	6-19	20-36	9-20	13-15	8-11	16-34	10-12	16	16-20	17	12
palp2	30-75	40-50	50-75	40	37-50	50-55	50	50	60-75	60	50
palp3	115-170	250-280	150-220	100	125-135	180-220	140	212	196-200	260	170
palp4	125-260	250-270	150-230	110	90-175	200-280	170	200	200-215	260	190
palp5	160-350	280-310	250-350	150	225-250	275-340	225	300	300-350	580	250
Ac	12-17	12-50	16-19	11-13	10-15	20-24	15	16	12-15	?	27
Dc	10-21	10-43	11-15	8-11	9-13	8-14	10-11	11	15-16	9	15
Pa	3-5	3	3	3	3-4	4	3	3	3-5	4	3
Sets	9-14	11-24	7-16	10-11	8-12	11-17	11-12	10	15-16	13	6+
VR	1.17-1.24	1.11-1.15	1.12-1.24	1.18	1.2-1.25	1.1-1.25	1.1-1.2	1.16	1.1	1.1	1.1
R	17-25	22-28	21-28	20	7-12	14-31	20-21	22	25-28	20-26	22
R1	11-18	20-26	13-30	16	1-9	19-29	20	20	19-25	17-31	14
R4+5	13-29	30-39	13-23	40	0-20	24-47	28-44	28	35-40	19-23	14
Sq	5-11	7-13	7-11	9	7-8	11-16	8-14	11	12-19	12-14	7
<b>P1</b>											
Fe	650-1000	1280-1460	940-1640	650-950	700-740	980-1200	920-1000	1200	1100-1260	1080-1320	1040
Ti	720-1050	1400-1560	940-1560	800-880	660-720	1100-1220	920-970	1260	1180-1320	1200-1460	1040
Tal	820-1000	1350-1520	1440-1500	740-850	660-720	1080-1330	1000-1050	1300	1340	1260-1680	-
Ta2	340-520	680-720	640-680	430-470	300-350	500-680	540-550	640	680-720	580-740	-
Ta3	350-400	600-680	520-600	330-350	240-280	560-600	540-550	540	500-720	480-620	-
Ta4	250-320	500-560	300-680	260-280	200-230	320-440	300-310	420	380	380-490	-
Ta5	80-160	200-210	180-200	140-150	110-120	160-200	140-150	180	200-220	90-220	-
LR1	0.94-1.14	0.96-1.0	1.07-1.16	0.84-1.05	0.92-1.09	1.0-1.2	1.1	1.04	1.08-1.14	1.1-1.2	-
BV1	1.95-1.14	1.90-2.0	2.22-2.62	1.70-2.06	2.2-2.4	1.94-2.21	2.04-2.17	1.72	1.93-2.07	2.37-2.15	-
SV1	1.85-2.3	1.91-2.04	1.65-1.76	2.47-3.05	1.9-2.15	1.65-1.94	1.84-1.87	1.97	1.70-1.89	1.67-1.8	-
<b>P2</b>											

.....continued on the next page

TABLE 1. (Continued)

MALE	<i>azeylelandica</i>	<i>cinctipes</i>	<i>donedwardi</i>	<i>homodivisa</i>	<i>kakadu</i>	<i>neocaledonica</i>	<i>noongar</i>	<i>phengari</i>	<i>plumosa</i>	<i>stictoptera</i>	<i>zeylandica</i>
n=	5-8	4	4	1-2	4	10	2	1	4	3	1
Fe	500-900	1440	1000-1300	950	720-800	1100-1200	920	1200	1200-1320	1200-1440	1080
Ti	600-1000	1320-1340	800-1600	700	650-730	1060-1160	870	1080	1160-1240	1150-1360	1000
Ta1	460-580	720	500-800	500	400-420	620-700	520	680	720-800	640-800	-
Ta2	190-300	380-460	280-440	250	160-180	320-420	290	380	420-440	360-420	-
Ta3	160-230	300-340	320-340	210	130-150	260-320	240	280	320-440	280	-
Ta4	110-170	180-220	160-260	150	90-120	160-220	160	200	240	200-240	-
Ta5	60-100	100-120	120-160	110	70-90	100-120	110	120	160	100-120	-
LR2	0.49-0.61	0.50-0.52	0.57-0.60	0.71	0.46-0.51	0.58-0.62	0.59	0.63	0.62-0.67	0.56-0.59	-
BV2	3.1-3.9	3.21-3.57	2.78-3.67	2.94	3.55-3.69	2.9-3.41	2.89	3.35	2.7-2.8	3.0-3.27	-
SV2	1.6-3.3	3.9-4.1	3.18-3.72	3.3	3.9-4.5	3.0-3.3	3.44	3.02	3.2-3.3	3.70-3.75	-
<b>P3</b>											
Fe	700-1000	1400-1440	940-1500	-	720-860	1100-1200	930	1220	1200-1300	1240-1440	1050
Ti	760-1200	1340-1400	1060-1800	-	720-860	1100-1260	1050	1360	1360-1500	1280-1520	1240
Ta1	760-1200	800-860	700-1040	-	500-510	760-840	730	1160	1040-1060	860-1000	-
Ta2	560-800	380-410	420-600	-	260-270	400-520	410-430	480	540-580	500-580	-
Ta3	280-440	600-340	320-480	-	220-230	320-420	320-340	400	460	400-440	-
Ta4	230-350	200-220	220-300	-	130-150	220-380	210	260	300-320	260-300	-
Ta5	60-100	100-120	140-160	-	80-90	120	110-120	140	160	140-160	-
LR3	0.6-0.7	0.55-0.57	0.64-0.66	-	0.68-0.71	0.63-0.76	0.69-0.70	0.85	0.70-0.76	0.68	-
BV3	2.5-3.1	2.74-3.13	2.27-2.67	-	2.74-2.98	2.4-3.0	2.48-2.49	2.92	2.46-2.57	2.56-2.71	-
SV3	2.6-3.1	3.9-4.1	2.85-2.97	-	2.82-3.18	2.7-3.0	2.70-2.71	2.49	2.46-2.64	2.9-2.96	-



TABLE 2. Morphometric data for larvae of *Riethia* Kieffer

LARVA	azeylandica	cinctipes	donedwardi	hamodivisa	neocaledonia	noongar	noongar	paluma	phengari	plumosa
n=	10	9	6	1,2	5	8	1	1	4	2
B.l.	5.8–7.2	6.0	7.0–9.4	?	7.2–8.2	6.0	?	?	6.8–7.2	9.0
H.l.	500–550	410–500	480–520	350	470–510	450–550	315	600	400–420	500
pm.l.	190–210	175–200	200–210	150	200–225	190–230	125	190	175	200–220
Ant 1	112–122	78–95	90–110	83–94	90–112	96–122	65	80	86–120	120–126
Ant 2	24–30	21–25	26–30	26–27	23–27	22–28	20	20	20–34	26
Ant 3	14–16	25–35	24–28	15–20	35–40	18–22	18	18	18–22	20–22
Ant 4	10	13–18	16–20	10–12	12–15	14–20	11	18	10–14	13–14
Ant 5	6	6–8	7–8	5	7–8	8–10	6	7	6–8	8
AR	1.75–2.1	1.1–1.25	1.1–1.2	1.4	1.0–1.2	1.36–1.48	1.2	0.90	1.4–1.5	1.7–1.8
pedestal	50x60	reduced	reduced	24x40	reduced	60x25–30	50x55	reduced	reduced	50x50
blade	56–62	87–93	74–78	62	75–90	64–72	48	50	54–64	70–72
st	8–9	10	12–13	?	9–10	8	8	?	12	?
Pmd	4	4	3–4	3–4	4	4	4	4	3–4	4
Md	160–182	140–165	160–178	130–136	155–175	170–180	122	168	130–160	190–196
M.w.	128–152	115–130	142–156	120	137–150	115–120	90	135	140–160	150–170
Vm.w.	120–144	120–160	156–168	108	125–140	145–150	96	155	160–180	165–175
Vm-mR	1.0	1.0–1.2	1.25	0.9	0.95–1.0	0.8	1.1	1.15	1.1–1.2	1.0–1.1
As.n	8	7–8	7–8	8	8–9	7–8	?	8	8	8
As.l	520–540	600–650	620–700	440	600–660	440–600	?	700	520	360
Pc.h	100	75–85	88–160	?	80–150	110–120	?	20	112	35–50
Pc.w	30–36	25–35	28–50	?	25–35	25–40	?	35	25	60–95

TABLE 2. (Continued)

LARVA	queenslandensis	stictoptera	wazeylandica	zeylandica	larva A	larva B	larva C
n=	6	6	2-3	2	5	2	6
B.l.	4.6-6.5	?	6.0	?	?	?	?
H.l.	400-450	550	500	450-470	375-440	500-600	490-550
pm.l.	170-205	215-240	150	150-160	125-132	200-205	190-205
Ant 1	95-112	94-110	80-82	90	65-80	77-100	122-133
Ant 2	27-33	24-26	24-26	26	25-30	23-25	32-38
Ant 3	12-13	30-32	16-17	17	20-22	33-40	23-30
Ant 4	9-12	18	10	10	12-14	19-23	12-15
Ant 5	7-10	6-8	6-8	5	6	7-8	7-8
AR	1.75-2.0	1.1-1.25	1.4-1.6	1.4	0.9-1.2	0.9-1.1	1.4-1.66
pedestal	40-60x40-45	reduced	reduced	reduced	50x50	50-65x70	65x90
blade	42-52	70-78	48-50	70	75-78	87-106	80-85
st	7-10	7-10	6	?	10	10	11
Pmd	5	4	?	3/4	4	4	4-5
Md	119-133	180-198	146	125	125-130	164-185	155-175
M.w.	105-120	136-164	120	100-105	90-92	137-155	125-145
Vm.w.	105-125	140-175	94	100-105	90-95	164-175	130-145
Vm-mR	0.9-1.0	1.06-1.17	0.75	1.05	1.0	1.20-1.25	1.0-1.1
As.n	8	8	8	7	8-9	8	8-9
As.l	410-445	560-740	?	250	300	600	550
Pc.h	35-50	120-130	35	110-125	50-60	85	65
Pc.w	20-25	35-44	10	50	25-30	42	20

## Unreared larvae with molecular and morphological differentiation from reared, described species.

### *Riethia* larva 'A'

**Material examined**, larval head capsules only: AUSTRALIA, 4L, New South Wales, Currowan S.F., Cabbage Tree Ck., 35°34'S 150°02'E, 2.i.2009 (MV AU09CTCR1, 2, 4, 5); L, same, except 23.i.2000 (*Cranston & Dimitriadis*); L, Glenbog SF., Brown Mountain, Fastigata Rd, Rutherford Ck., 36°36'S 149°47'E, 909 m a.s.l, 4.ii.2009 (MV NSWGCR4).

Molecular data shows that four larvae from Cabbage Tree Ck (CTC) (collected 2.i.2009) are essentially identical and belong to a clade distinct from any others with molecular sampling. These larvae are smaller than any congener measured from Australia (Table 2). Although it is possible they might be 3<sup>rd</sup> instars, this seems unlikely given that in all other species in which 3<sup>rd</sup> and 4<sup>th</sup> instars are known, the size ratio of 4<sup>th</sup> to 3<sup>rd</sup> instar for sclerotised structures (head, postmentum and mandible lengths) is 1.6 (that is 4<sup>th</sup> is 160% length of 3<sup>rd</sup>), and is nearer to 2 for the basal antennal segment. The small larva 'A' is only a negligible outlier to the smallest other 4<sup>th</sup> instars described (Table 2). The larvae show some unexpected variability in morphology: the antennal flagellum can extend to the base of the 4<sup>th</sup> antennal segment or significantly beyond the terminal, and the clypeus approximates that of *R. queenslandensis* (Fig. 6M) in shape and size, especially with regard to the curved posterior boundary but with weaker antero-lateral flare. Given that these 4<sup>th</sup> instars can be keyed, significant features from the antenna can be recognised as being the low AR of 0.9–1.1, 3<sup>rd</sup> segment shorter than the 2<sup>nd</sup> and with an evenly and completely sclerotised wall to the 3<sup>rd</sup> segment. Morphology of this larval molecular cluster suggests 2 additional unreared larvae (lacking molecular data) belong to the clade. The occurrence of this larval type in both Cabbage Tree and Rutherford Creeks, but seemingly nowhere else, cannot allow association by sympatry as both sites support several coexisting species.

### *Riethia* larva 'B'

(Fig. 5H)

**Material examined**, larval head capsules only, AUSTRALIA, 2L., Queensland, nr Mareeba, Davies Ck., 17°01'S 145°35'E, 3.ix.2005 (MV FNQ7\_6 (3i), MV FNQ7\_8 (4i); 2L, Cloudy Ck., 18°59.50'S 146°12.30'E (*Krosch*) (MV FNQCCR3, 2).

New South Wales, 2L (1 3i, 1 4i, Clyde R., Brooman, 16.ii.2009; 2L, Currowan S.F., Cabbage Tree Ck., 35°34'S 150°02'E, 3.i.2009 (MV AU09CTCR14, 15).

Four larvae form a clade based on molecular data, supported by ordinations of mensural data versus CO1 genetic data (N. Herold *unpubl. obs.*). Morphologically these resemble larvae of *R. cinctipes* in the characteristically thinned cuticle on one side of antennal segment 3, beside, and perhaps associated with, the Lauterborn organs (Fig. 5H). The major distinction is in antennal segment 4 being subequal to slightly shorter than the 2<sup>nd</sup> (80–100%), whereas in *cinctipes* it is significantly and consistently shorter than the 2<sup>nd</sup> (by c. 60%) (Table 2).

Larva type B is unreared, and cannot be associated due to sympatry with others.

Both molecular vouchers from Davies Ck. (FNQ7–6, FNQ7–8) are from Cranston *et al.* (2011) for *Riethia* species 3 and 4, separated morphologically due to earlier failure to recognize presence of 3<sup>rd</sup> and 4<sup>th</sup> instars of the same species.

### *Riethia* larva 'C'

(Fig. 6C)

**Material examined**. New South Wales, 5L, Currowan S.F., Cabbage Tree Ck., 35°34'S 150°02'E, 2.i.2009 (*Cranston*) (MV AU09CTCR6–10); Glenbog SF., Brown Mt., Fastigata Rd., Rutherford Ck., 36°36'S 149°47'E, 909 m a.s.l, 4.ii.2009 (MV NSWGCR8), 2L, same except 27.xi.2010 (MV NSWBMR1, 2).

Five larvae coded CTCR6–10 are identical on DNA for CO1 and combined genes, and similarly cluster in similarity of morphology. The head capsule is evenly pale coloured with dark teeth of mentum and mandible, squat but distinct antennal pedestal with AR c. 1.5–1.7, and the clypeus is quite large (65–80 µm wide, 45–48 µm tall) and

uniquely is subovate (Fig. 6C) with clypeal setae approximated and located antero-medially. An antennal feature seems characteristic although it is difficult to quantify—segment 1 is narrower proximally becoming visibly more dilate distally. This narrowing is despite the Ring Organ being located proximally within this narrower basal section. Mensural features see Table 2.

## Key to *Riethia* species

### Adult male (*R. paluma* unknown)

1	Legs banded	2
-	Legs pale, unbanded	5
2	Gonostylus short and triangular, tapering to point (Fig. 1E). Superior volsella simple lobe without digitus (Fig. 2K)	<i>stictoptera</i> Kieffer
-	Gonostylus elongate oval. Superior volsella with digitus	3
3	Digitus of superior volsella narrow at base, dilate medially. Inferior volsella with pectinate setae (Fig. 2F)	<i>neocaledonica</i> sp.n.
-	Digitus of superior volsella broadest at base, tapering. Inferior volsella lacks pectinate setae	4
4	Digitus of superior volsella broad, tapered to tooth (Fig. 2B). Wing with dark band	<i>cinctipes</i> Freeman
-	Digitus of superior volsella tapered evenly to rounded apex (Fig. 2C). Wing plain, unpigmented	<i>donedwardi</i> sp.n.
5	Some setae on inner margin of gonostylus apically plumose (Fig. 1C, D)	6
-	All gonostylar setae simple (Fig. 1A, B, E, F)	7
6	Gonostylus attenuated, apex abruptly angled (Fig. 1C)	<i>phengari</i> sp.n.
-	Gonostylus tapered conventionally (Fig. 1D)	<i>plumosa</i> Freeman
7	Digitus of superior volsella with 1 pectinate scale (Fig. 2L)	<i>wazeylandica</i> sp.n.
-	Digitus without pectinate setae	8
8	Inferior volsella with only simple setae (Fig. 2G)	<i>noongar</i> sp.n.
-	Inferior volsella with several pectinate scales (Fig. 2D, E, F)	9
9	Inferior volsella distally bare, with 3 pectinate scales (Fig. 1B, 2D)	<i>hamodivisa</i> sp.n.
-	Inferior volsella microtrichiose, with 5–7 pectinate scales	10
10	Digitus of superior volsella slender from base, bearing 2 long setae; inferior volsella setose from base (Fig. 2E)	<i>kakadu</i> sp.n.
-	Digitus of superior volsella broad at base, lobe bearing 3–10 short setae (Figs 2A, K, L, M). Inferior volsella bare at base	11
11	Pseudovolsella a prominent lobe (Fig. 1F, 2M). New Zealand	<i>zeylandica</i> Freeman
-	Pseudovolsella absent (no more than inner contour of gonocoxite). Australia	12
12	Inferior volsella with pectinate setae subapical on ridge, on same plane as superior volsella (Fig. 2J)	<i>queenslandensis</i> sp.n.
-	Inferior volsella curved, broad, lacking ridge, more ventral than superior volsella (Fig. 2A)	<i>azeylandica</i> sp.n.

### Pupa

1.	Hook row on tergite II medially divided (Fig. 3G)	2
-	Hook row on tergite II complete	3
2.	Conjunctival spinule bands continuous (Fig. 3G). TII and III near infilled with spinules, VI with paired posterior patches of spinules (Fig. 3G)	<i>hamodivisa</i> sp.n.
-	Conjunctival spinule bands interrupted. TII without spinules, III with very reduced pattern, VI posteriorly bare	<i>paluma</i> sp.n.
3.	Conjunctival spinule bands on III and IV, V bare (Fig. 3D)	4
-	Conjunctival spinule bands on III, IV & V (Fig. 3E, F)	10
4.	Conjunctival spinule bands both medially interrupted (Fig. 3H)	<i>kakadu</i> sp.n.
-	Conjunctival spinule bands continuous (Fig. 3D)	5
5.	Tergite II broadly spinulose, with anterior broad transverse spinule area extending to wide postero-median area (Fig. 3D)	6
-	Tergite II with few spinules, restricted to postero-median area	9
6.	Cephalic area without warts (Fig. 3A)	7
-	Cephalic area with distinct warts (Fig. 3B)	8
7.	Tergites mid-brown. Comb with subdominant spines (Fig. 3I)	<i>azeylandica</i> sp.n.
-	Tergites almost translucent. Comb with one dominant spine (Fig. 4J)	<i>phengari</i> sp.n.
8.	TVII (Fig. 4A) and all sternites bare. Cephalic warts separated at base, tapering (Fig. 3B)	<i>noongar</i> sp.n.
-	TVII spinulose (Fig. 4M), sternites VI–VII spinulose in posterior 1/3, VIII less so (Fig. 4N). Cephalic warts rounded, near contiguous from base to rounded apex	<i>queenslandensis</i> sp.n.
9.	Pedes spurii B on II (Fig. 4D). Tergite II with spinule area narrower than hook row (Fig. 4D)	<i>stictoptera</i> Kieffer
-	Pedes spurii B absent. Tergite II with spinule area as wide as hook row (Fig. 4C)	<i>plumosa</i> Freeman
10.	Conjunctival spinule bands near merged with posterior tergal spines. Tergite VIII with posterior spinule areas, anal lobe dense	



- spinulose (Fig. 3E).....*cinctipes* Freeman
- Conjunctival spinule bands clearly separated from posterior tergal spines. Tergite VIII and anal lobe with few or no spinules (Fig. 3F) ..... 11
- 11. Conjunctival spinule bands on III, IV & V c.10 spines deep, dense and broad (Fig. 3F)..... *donedwardi* sp.n.
- Conjunctival spinule bands on III and IV 3–5 spinules deep, sparse and bands narrower; on V sparser, narrower (Fig. 4L) ... 12
- 12. Conjunctival spinule band on V clearly divided medially (Fig. 4L). Exuviae golden-brown, with dark apophyses. New Caledonia.....*neocaledonica* sp.n.
- Conjunctival spinule band on V sparse, continuous. Exuviae pale, with indistinct apophyses. .... 13
- 13. Segment V with L setae simple (Fig. 4O). New Zealand..... *zeylandica* Freeman
- Segment V with 3 L setae all taeniate. Western Australia ..... *wazeylandica* sp.n.

#### Larva (*kakadu* not known)

- 1. Antennal ratio < 1.25 (Fig. 5F)..... 2
- Antennal ratio  $\geq$  1.4 (Fig. 5G–I) ..... 7
- 2. Postmentum dark contrasting with paler genae ..... *stictoptera* Kieffer
- Postmentum and genae yellow / gold, unicolorous ..... 3
- 3. Mentum and all mandibular teeth golden-yellow. Western Australia..... *donedwardi* sp.n.
- Mentum and inner mandibular teeth golden-brown to brown. Not Western Australia ..... 3
- 4. Antennal segment 3 with all walls evenly sclerotised, slightly shorter than segment 2. Prementum and mandible < 130  $\mu$  .... larval sp. ‘A’
- Antennal segment 3 with walls partly thinned, longer than segment 2 (Fig. 5G,H). Prementum and mandible > 150  $\mu$  .... 5
- 5. Antennal segment 3 with very thin wall (Fig. 5G). Clypeus broad, lateral margin indented, 2 $\times$  as wide as long (Fig. 6H). New Caledonia ..... *neocaledonica* sp.n.
- Antennal segment 3 thin-walled, narrowed on 1 side, the other conventional (Figs. 5E, 5H). Clypeus lozenge-shaped, elongate-ovoid, 3 $\times$  as wide as long (Fig. 6E). Eastern Australia ..... 6
- 6. Antennal segment 4 subequal to 2<sup>nd</sup> (c. 80–100%) (Fig. 5H). Antennal pedestal strong (> 50 $\mu$  high) ..... Larval sp. ‘B’
- Antennal segment 4 clearly shorter than 2<sup>nd</sup> (c. 60%) (Fig. 5E). Antennal pedestal weak (c. 30 $\mu$  high)..... *cinctipes* Freeman
- 7. Mentum and all mandibular teeth golden-yellow ..... 8
- Mentum and inner mandibular teeth brown ..... 9
- 8. Clypeus large, long and wide (c. 75  $\times$  50 $\mu$ m), with clypeal setae positioned anterolaterally (Fig. 6L) ..... *plumosa* Freeman
- Clypeus smaller, shorter and narrower (c. 55  $\times$  32 $\mu$ m), with clypeal setae positioned more medially (Fig. 6G) ..... *hamodivisa* sp.n.
- 9. Antennal pedestal strong (> 40  $\mu$ m long and wide) ..... 10
- Antennal pedestal weak or absent ..... 12
- 10. Antennal ratio <1.5. Head pale. Clypeus subovoid, narrowed anteriorly (Fig. 6C)..... Larval sp. ‘C’
- Antennal ratio >1.7 (Fig. 5D). Posterior head dark. Clypeus broad anteriorly, tapered posteriorly (Figs. 6D, M)..... 11
- 11. Clypeus evenly tapered laterally, transverse posteriorly (Fig. 6D) ..... *azeylandica* sp.n.
- Clypeus anteriorly flared, rounded posteriorly (Fig. 6M) ..... *queenslandensis* sp.n.
- 12. Clypeus posteriorly rugulose (Fig. 6K). Ventromental plates 10–20% longer than mentum width. .... *phengari* sp.n.
- Clypeus smooth. Ventromental plates subequal to c. 20% shorter than mentum width ..... 13
- 13. Ventromental plates subequal to width of mentum. New Zealand..... *zeylandica* Freeman
- Ventromental plates short, 75–80% width of mentum. Western Australia ..... 14
- 14. Clypeus (Fig. 6I) trapezoid, broader anteriorly, anterior and posterior margins straight; max. width to max length ratio < 1.5. Clypeal setae closer to anterior margin ..... *noongar* sp.n.
- Clypeus (Fig. 6O) somewhat ovoid, anterior margin straight, posterior margin medially indented, lateral margins slightly indented; max. width to max. length ratio c. 2.0. Clypeal setae retracted more posteriorly ..... *wazeylandica* sp.n.

## Discussion

During the 3 past decades of study of austral Chironomidae, *Riethia* has been revealed to be more diverse than was supposed based on described adult morphology. Notably the ‘catch-all’ taxon *R. zeylandica* actually is restricted to New Zealand: in Australia it comprises several species that can be differentiated as males, pupae and larvae. An endemic species to New Caledonia has been reared, and elsewhere in the Austropacific region full life histories are known now for many taxa. In South America knowledge of all stages also has grown (Trivinho-Strixino et al. 2009, Neubern *et. al.* 2011). None-the-less several taxa based on unreared immature stages remain informally described and problematic. These insects have proved difficult to rear, and remarkably few intercepts are made of associated pupa and adults from drift—emergence at the water surface appears to be rapid and successful. A further complication is that molecular evidence for species discrimination and relationships have been limited by several factors. Essentially only larvae were available for use, which placed reliance upon the detection of differentiating characters

in this life stage, yet largely lacking adequate sample sizes to assess the credibility of the states used, including the novel, but poorly tested, shape of the clypeus and subtle differences in the larval antenna. Dependence on larvae for molecular insights proved often unreliable: many locations for specific rarer taxa were sampled but with poor outcomes. The immature stages of *Riethia* are remarkably sympatric, akin to species of *Eukiefferiella* Kieffer in northern European streams. Well surveyed, including repeatedly revisited, running water sites from the tropical north to temperate south-eastern Australia each may have 4–5 taxa, even synchronously as evidenced by drifting pupal exuviae that track recent emergence. Although it is hazardous ever to assume associations of immature stages even from systems apparently with only 1 taxon present, such diversity of *Riethia* completely precludes inferring any such ‘linkages’ by location. The paucity of rearings is reflected in the informal recognition here of 3 larval types for which barcode genetic data clusters are associated with distinctive larval head capsule morphologies (larva ‘A’, ‘B’ and ‘C’).

With such provisos, how robust is this study? Foremost, features of the adult genitalic morphology appear very dependable in discriminating species, with reliability indicated by informative pupal features with little species-level variation. In addition species remarkably track biogeography and some additional support is provided by molecular data. Only *R. paluma* is described here without a male, from a pharate female with a distinctive pupa and pattern-winged and -legged adult unallocatable to any other taxon.

Finally, this paper provides little data to add to the evolutionary relationships in the proposed tribal grouping Pseudochironomini beyond that provided in Cranston *et al.* (2010). Some errors in barcoded taxa in databases have been revealed (see above under *R. stictoptera* and *R. azealandica*) and other vouchers are now placed in correct taxa. The allocation of two misidentified vouchered *R. stictoptera* (q.v.) to *Kiefferulus* casts additional doubt that the minimally sampled (by taxa and genes) NJ tree of Qi *et al.* (2017) adds anything useful to our understanding of the evolution of *Riethia* within a doubtfully monophyletic Pseudochironomini.

## Acknowledgments

Early continent-wide collections from which this material derives were made under funding from Australian Biological Resources Study (ABRS), with subsequent support for survey of Alligator Rivers Region (by Office of Supervising Scientist, via Chris Humphrey), Far North Queensland (funded by Cooperative Research Centre for the Wet Tropics, via Nigel Stork and Craig Moritz) and the upper Murray River (funded by the Murray Darling Freshwater Research Centre (MDFRC) via Terry Hillman). Between 2000 and 2011, funding for combined morphological and molecular studies of Chironomidae came initially from Evert Schlinger’s endowment in Systematic Entomology to Cranston at the University of California, Davis (2000–2010), and by National Science Foundation (NSF) award 0933218 ‘MIDGEPEET—A Collaborative Effort to Increase Taxonomic Expertise in Understudied Families of Nematoceros Diptera’ via J. K. Moulton, University of Tennessee. Molecular data originated from an unpublished MS thesis by Nick Herald, University of California, Davis and I thank him for making it available, and to Matt Krosch (ex-QUT) for revisiting these data.

Australian biologists, particularly Jon Martin (University of Melbourne), Rob Cook (MDFRC, Wodonga) and Brendan McKie during his PhD program at James Cook University have diligently sought to rear local species. Matt Krosch collected many larval *Riethia* as by-catch in other projects and Ian Wright collected pupal exuviae between far north Queensland and southernmost Tasmania. The late D.H.D. (Don) Edward collected and reared Western Australian species, and I take pleasure in naming a species for him. Robert Hoare of the New Zealand Arthropod Collection, Auckland, reviewed my proposed names for the new species and saved me from several nomenclatural infelicities, for which I thank him profusely. I thank Jon Martin and Matt Krosch for reviewing a version of this manuscript: remaining errors lie at my door.

I acknowledge all permits to collect aquatic midges issued by appropriate agencies, whose acronyms and personnel have undergone too many changes while true threats to biodiversity remain unaddressed.

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